

1986 ANNUAL REPORT FOR THE FISHERY MANAGEMENT PLAN
FOR THE BOTTOMFISH AND SEAMOUNT GROUND FISH FISHERIES
OF THE WESTERN PACIFIC REGION



JANUARY 1988

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for the

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TABLE OF CONTENTS

List of Figures	iii
List of Tables	v
Glossary of Terms	vi
Introduction	1
Hawaiian Islands	4
I. Fishery Performance Data	4
II. Recent Research and Survey Results	26
III. Habitat Conditions and Recent Alterations.	30
IV. Enforcement Activities and Problems	31
V. Administrative Actions	31
VI. State/Territory Management Actions	31
VII. Assessment of Need for Council Action	32
VIII. Recommendations for Council Action	32
IX. Estimated Impacts of Recommended Action.	32
Territory of American Samoa	33
I. Fishery Performance Data	33
II. Recent Research and Survey Results	45
III. Habitat Conditions and Recent Alterations.	45
IV. Enforcement Activities and Problems	45
V. Administrative Actions	45
VI. State/Territory Management Actions	46
VII. Assessment of Need for Council Action	46
VIII. Recommendations for Council Action	46
IX. Estimated Impacts of Recommended Action.	46
Commonwealth of the Northern Mariana Islands	47
I. Fishery Performance Data	47
II. Recent Research and Survey Results	59
III. Habitat Conditions and Recent Alterations.	59
IV. Enforcement Activities and Problems	59
V. Administrative Actions	59
VI. State/Territory Management Actions	59
VII. Assessment of Need for Council Action	59
VIII. Recommendations for Council Action	59
IX. Estimated Impacts of Recommended Action.	60
Territory of Guam	61
I. Fishery Performance Data	61
II. Recent Research and Survey Results	75

III.	Habitat Conditions and Recent Alterations.	75
IV.	Enforcement Activities and Problems	75
V.	Administrative Actions	75
VI.	State/Territory Management Actions	75
VII.	Assessment of Need for Council Action	75
VIII.	Recommendations for Council Action	75
IX.	Estimated Impacts of Recommended Action.	76

References	76
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Appendix A. Summary Tables and Figures of the HDAR Catch
Report Data for the Years 1985 and 1986.

Appendix B. An Economic Description and Assessment of the
Hawaiian Bottomfishery.

Appendix C. A HL Administrative Report Prepared as a Stock
Assessment of the Hawaiian Bottomfishery.

LIST OF FIGURES

Figure 1.	The HDAR C-3 form which is used by commercial fishermen to report fish catch data.	5
Figure 2.	Main Hawaiian Islands, DAR Fisheries Chart Number 2	6
Figure 3.	Northwest Hawaiian Islands, DAR Fisheries Chart Number 3	7
Figure 4.	Annual trends in fisheries types in the Hawaiian Islands for 1985 and 1986	8
Figure 5A.	Management unit species catch totals for the Main Hawaiian Islands in 1985	17
Figure 5B.	Management unit species catch totals for the Main Hawaiian Islands in 1986	17
Figure 6.	Management unit species catch totals for the Northwest Hawaiian Islands in 1985	18
Figure 7.	Management unit species catch totals for the Northwest Hawaiian Islands in 1986	19
Figure 8.	Total catch and relative CPUE for the Hawaiian Islands by year and by zone	20
Figure 9.	Average monthly bottomfish landings in American Samoa between 1982 and 1984	34
Figure 10.	Average monthly landings in American Samoa between 1982 and 1984	34
Figure 11.	Total bottomfish landings in American Samoa between 1982 and 1985	35
Figure 12.	Annual trends in fisheries types in American Samoa between 1982 and 1984	35
Figure 13.	Total number of commercial fishing vessels in American Samoa between 1980 and 1987	37
Figure 14.	Bottomfish catch rates in American Samoa between 1982 and 1986	37
Figure 15.	Total pounds caught in various fishing categories in the CNMI between 1979 and 1986	48
Figure 16.	Annual trends of fishery landings in the CNMI between 1979 and 1986	48

Figure 17. Average monthly landings of bottomfish in the CNMI between 1979 and 1986	49
Figure 18. Total commercial landings in the CNMI between 1979 and 1986	49
Figure 19. Total commercial bottomfish landings in the CNMI between 1983 and 1986	52
Figure 20. Number of bottomfish landings and trips in the CNMI between 1983 and 1986	52
Figure 21. Number of vessels making commercial bottomfish landings in the CNMI between 1983 and 1986	54
Figure 22. Average number of bottomfish landings per trip in the CNMI between 1983 and 1986	54
Figure 23. Total landings (pounds) in various fishing categories in Guam between 1979 and 1984	62
Figure 24. Commercial landings (pounds) on Guam between 1979 and 1984	62
Figure 25. Average bottomfish trip length, catch per trip and catch per hour fished in Guam between 1983 and 1987	66
Figure 26. Total commercial bottomfish landings (in pounds and dollars) in Guam between 1979 and 1986	68
Figure 27. Number of fishing vessels making commercial bottomfish landings in Guam between 1983 and 1986	68
Figure 28. Catch and effort estimates for Guam between 1979 and 1984	69
Figure 29. Bottomfish trip length, catch per trip and catch per hour for Guam between 1979 and 1984	69

LIST OF TABLES

Table 1.	Definitions of bottomfishing areas and zones in the Hawaiian Islands	8
Table 2.	Total catch in pounds by area and month for 1985 . .	10
Table 3.	Total catch in pounds by area and month for 1986 . .	10
Table 4.	Pounds sold and ex-vessel revenues in 1985 and 1986	11
Table 5.	Total catch, effort, and CPUE by species in 1985 . .	12
Table 6.	Total catch, effort, and CPUE by species in 1986 . .	13
Table 7.	Species composition of 1985 bottomfish landings in the Hawaiian Islands by area	15
Table 8.	Species composition of 1986 bottomfish landings in the Hawaiian Islands by area	16
Table 9.	American Samoa 1982 commercial landings of bottomfish species	38
Table 10.	American Samoa 1983 commercial landings of bottomfish species	39
Table 11.	American Samoa 1984 commercial landings of bottomfish species	40
Table 12.	Species composition of landings (number of records) recorded from American Samoa	41
Table 13.	Annual commercial bottomfish landings in the CNMI between 1979 and 1985	50
Table 14.	Species composition of landings (number of records) reported in the CNMI between 1981 and 1986	56
Table 15.	Bottomfish landings in Guam between 1979 and 1986 . .	63
Table 16.	Guam DWAR 1979-1984 annual bottomfishing creel survey summary	70
Table 17.	Species composition of landings (number of records) recorded from Guam between 1979 and 1986	70

GLOSSARY OF TERMS

<u>Abundance</u>	The number of fish of a species present in an area of interest over a specified unit of time.
<u>BMUS</u>	Bottomfish management unit species. These are the commercially important bottomfish species which are outlined in the Introduction of this report.
<u>Catch</u>	The number or weight of a particular species or group of species taken in a unit of time.
<u>Catch-Per-Unit of-Effort (CPUE)</u>	The average catch taken by a defined unit of fishing effort. In the bottomfish fishery, for example, the number or weight of bottomfish caught per vessel per day or per line-hour of fishing.
<u>CNMI</u>	Commonwealth of the Northern Mariana Islands.
<u>DAWR</u>	Guam Division of Aquatic and Wildlife Resources.
<u>DFW</u>	Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife.
<u>Effort</u>	A numerical measure of the amount of gear and time used in an attempt to catch fish. Effort may be expressed in terms of number of hooks fished per day, number of boat days, man hours, line hours, etc.
<u>Fishery</u>	A fishery is a composite of the following essential components: a resource consisting of a population of a species or set of species usually with similar ecological requirements or characteristics; a number of fishermen who regularly exploit the resource, together with their boats and equipment for harvesting and handling fish; and a market in which fishermen can sell their catch.
<u>Fishery Conservation Zone (FCZ)</u>	U.S. waters from the seaward boundary of a State or Territory to 200 nautical miles from the shoreline.

Fishery
Management
Plan (FMP)

A plan prepared by the Council and implemented by the Department of Commerce for the conservation and management of fishery resources in the Fishery Conservation Zone.

Growth-
Overfishing

Overfishing which is a direct result of harvesting fish before they have attained an optimum size to sustain population productivity.

Hancock
Seamounts

That portion of the FCZ in the NWHI west of 180° 00' W. longitude and north of 28° 00' N. latitude.

HDAR

Hawaii Division of Aquatic Resources.

KNK

Bottomfishing area in the Main Hawaiian Islands zone defined as those fishing areas around Kauai, Niihau and Kaula.

Magnuson Fishery
Conservation and
Management Act
(MFCMA)

Federal law (P.L. 94-265, passed in 1976 and amended several times in subsequent years) covering fishing activity in U.S. waters between State waters and 200 nautical miles from the coastline.

Main Hawaiian
Islands
(MHI)

The high islands of the State of Hawaii consisting of Niihau, Kauai, Oahu, Molokai, Lanai, Maui, Kahoolawe, and Hawaii (from 154° W. Longitude to 161° 20' W. Longitude).

Management
Unit

A species or a group of fish species affected or exploited by the same fishery or fisheries.

Management
Unit Species
(MUS)

In this Annual Report, the MUS include approximately 22 species of deepwater bottomfish and seamount groundfish.

<u>MLKM</u>	Bottomfishing area in the Main Hawaiian Islands zone defined as those fishing areas around Maui, Lanai, Kahoolawe, Molokai and Penguin Bank.
<u>Maximum Sustainable Yield (MSY)</u>	The greatest average amount, in theory, that can be harvested from a population of fish on a continuing basis.
<u>Mortality</u>	Refers to the death rate in a population from natural and fishery causes. Together these constitute total mortality. Mortality rates can be considered on an instantaneous or an annual basis (instantaneous mortality rates are the limits approached by average rates over progressively shorter periods).
<u>National Marine Fisheries Service (NMFS)</u>	The NMFS has the primary Federal responsibility for the conservation, management, and development of living marine resources and for the protection of certain marine mammals and endangered species under numerous Federal laws. The Agency also has responsibilities to the U.S. commercial and marine recreational fishing industry, including fishermen, and to the States and the general public.
<u>Northwestern Hawaiian Islands (NWHI)</u>	The Hawaiian Islands archipelago lying to the west of 161° 20' W. longitude.
<u>OMWR</u>	American Samoa Office of Marine and Wildlife Resources.
<u>Optimum Yield (OY)</u>	The amount of fish which produces maximum benefits to the Nation, especially considering food production and recreational opportunities.
<u>Overfishing</u>	A term often used to describe fishing at a level of effort in excess of the level needed to obtain the MSY. The term is also used to imply that fishing has reduced stock to such a level that its

reproductive potential is reduced. Overfishing may occur in a fishery at different levels of effort for recreational and commercial users. This may occur, for example; when recreational users prefer fish of smaller size that commercial users.

Plan
Monitoring
Team (PMT)

A team appointed by the Council to prepare the fishery management plan and annual reports under the direction of the Council. The PMT utilizes inputs from all committees and panels as well as outside sources in developing the FMP.

PMUS

Pelagic management unit species defines those species which are commercially important to pelagic fishermen, exclusive of tunas.

Recruitment

The rate at which new fish (recruits) enter the fishery by reaching catchable size or reaching an age where their distribution and behavior makes them vulnerable to the fishing gear, or the total amount of recruits added in a given period of time (i.e., the recruitment rate integrated over the time period), or the process of adding recruits.

Stock

A population or portion of a population that can be treated as a single unit for management purposes.

Western Pacific
Regional Fishery
Management
Council
(WPREMC)

The Western Pacific Regional Fishery Management Council shall consist of the State of Hawaii, the territories of American Samoa and Guam, and the Commonwealth of the Northern Mariana Islands. It shall have authority over the fisheries in the Pacific Ocean seaward of the jurisdiction of such State, territories, Commonwealth, and possessions of the United States in the Pacific Ocean area out to 200 nautical miles from shore.

1986 ANNUAL REPORT OF THE BOTTOMFISH PLAN MONITORING TEAM

A Fishery Management Plan (FMP) for bottomfish and seamount groundfish was implemented by the National Marine Fisheries Service (NMFS) in August of 1986. The FMP was developed by the Western Pacific Regional Fishery Management Council (Council) and is designed to manage and optimally utilize bottomfish stocks in Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. One of the main features of the FMP is an annual review of the bottomfish fisheries by a Plan Monitoring Team (Team) designated by the Council. The yearly review is intended to document changes in the fishery, to determine if problems exist in the fishery, to examine solutions to existing or impending problems, and to develop recommendations for management action by the Council. This report is the first annual report on the fisheries for bottomfish in the Western Pacific Region.

Bottomfish species are typically caught with deep-sea handline gear. Species of bottomfish which are most important to handline fishermen are snappers, jacks, groupers and emperorfishes which inhabit submarine banks and slopes to depths of 200 fathoms. Hawaiian common names are used as a standard for the bottomfish management unit species throughout this report. These are given below.

Common Name	Abbreviation	Scientific Name
Hapuupuu	(HAP)	<u>Epinephelus quernus</u>
Kahala	(KAH)	<u>Seriola dumerili</u>
Kalekale	(KAL)	<u>Pristipomoides sieboldii</u>
Opakapaka	(OPA)	<u>Pristipomoides filamentosis</u>
Uku	(UKU)	<u>Aprion virescens</u>
Ehu	(EHU)	<u>Etelis carbunculus</u>
Onaga	(ONA)	<u>Etelis coruscans</u>
Ulua	(ULU)	<u>Caranx</u> and <u>Carangoides</u> spp.
Lehi	(LEH)	<u>Aphareus rutilans</u>
Gindai	(GIN)	<u>Pristipomoides zonatus</u>
Taape	(TAA)	<u>Lutjanus kasmira</u>
Butaguchi	(BUT)	<u>Pseudocaranx dentex</u>
White/Black Ulua	(WHT)	<u>Caranx ignobilis</u>

The bottomfish fishery is a mainstay of the small-scale developing fisheries of the Western Pacific Region. Boats engaged in commercial bottomfishing often represent the majority of commercial fishing enterprises in these areas and are important to the local economies. For many fishing vessels, bottomfishing makes the difference between profitable and unprofitable operation. Historically, the Hawaiian deep-sea handline fishery has been one of the most important in the State, for both the commercial and recreational sectors of the community. In 1986, the Hawaii bottomfish market revenue was an

estimated \$5.3 million, based only on the wholesale market purchases (See Appendix B).

There is a great need to manage bottomfish populations for several reasons. First, bottomfish resources are highly susceptible to rapid stock reductions. Additionally, recruitment and growth rates of many bottomfish species are slow. For instance, Hawaii fishermen have noted that after catch rates of an opakapaka population are reduced to a low level, it may take 3 years for the same population to become economically feasible for commercial exploitation again. If management of bottomfish is postponed until stock reductions become severe, it may take years before this resource can be utilized commercially, again.

The regulations of the FMP specifically outline the information needed to effectively manage bottomfish resources. This outline is given below.

- I. Fishery Performance Data
 1. Total landings (commercial and recreational) by species by area and by month
 2. Estimated ex-vessel revenues by species
 3. Fishing effort information
 - A. Number of vessels, number of trips, number of days fished and landings per trip
 - B. Species composition of landings, areas fished, catch per day by area and other indicators of fishery performance
 4. Biological characteristics of the landings, including size-frequency data for each species by area.
 5. Summary table of fishery status (This table presents 14 warning signs of a deteriorating fishery.)
- II. A Summary of Recent Research and Survey Results
- III. Habitat Conditions and Recent Alterations
- IV. Enforcement Activities and Problems
- V. Administrative Actions (data collection, reports and permits)
- VI. State/Territory Management Actions
- VII. Assessment of Need for Council Action
- VIII. Recommendations for Council Action
- IX. Estimated Impacts of Recommended Action

This outline is used in the annual report to assess the status of the bottomfish fishery in each of the four Western

Pacific regions.

Because of the broad spectrum of information needed to produce this report, inputs are provided by a number of agencies. In particular, the NMFS Office of Enforcement, the NMFS Southwest Fisheries Center Honolulu Laboratory (HL), the NMFS Southwest Region Western Pacific Program Office, the State of Hawaii Division of Aquatic Resources, the American Samoa Office of Marine and Wildlife Resources (OMWR), and the Guam Division of Aquatic and Wildlife Resources (DAWR) all provided information to the Team. The information provided was originally obtained to suit the particular agency's needs; therefore some inconsistencies are evident in this report. It is hoped that this report will provide a foundation which can be used as a guideline for future reports. Once standardization of information is attained, the management of bottomfish resources across the western Pacific will be much more feasible.

Although this report includes information on commercial landings only, the recreational (non-market) value of bottomfish landings is very significant. The proportion of the total main Hawaiian Islands' bottomfish landings attributed to the recreational component of the fishery has increased considerably in recent years. The National Marine Recreational Fishing Survey indicated that over 200,000 pounds of opakapaka and related species were caught in 1981 by recreational fishermen in Hawaii (NMFS, Honolulu Laboratory, unpublished data). It has also been estimated that 50% of the offshore fish catch on Guam is recreational in nature (K. E. Knudson, contract WPC 0983 progress report, 6/5/84). Thus, it is clear that recreational bottomfish landings are an important component in the fishery. Presently, the Council is in the process of designing a survey which will sample all fishermen who have a boat registration in the State of Hawaii. This survey should provide a means of obtaining quantitative data on recreational bottomfish catches in the Hawaiian Islands. By combining recreational and commercial harvest statistics, the status of the bottomfish fishery will be better understood on the Western Pacific. An understanding of both recreational and commercial components of the fishery will allow for managerial decisions which will better utilize this important resource in a more sustainable fashion and with more certainty.



MR. MAKA HOOKALA, FORMER ADVISOR TO WESTPAC, DISPLAYING ONAGA.

HAWAIIAN ISLANDS

This report on the Hawaiian Islands bottomfish fisheries is based on data collected by the Hawaii Division of Aquatic Resources (HDAR). Catch data from licensed commercial fishermen for the calendar years 1985 and 1986 are used, although information on other years is also reported. Fish catch data are reported to HDAR on a monthly basis by commercial fisherman on the C-3 form (Figure 1). This form lists species, days fished, areas fished, port of landing, number, pounds caught and sold, and price received. Each line in the body of the form is entered as one record into the commercial catch database. Detailed information on the reporting system can be found in the HDAR report, Hawaii Fisheries Statistics System Design Study, published in 1984.

The Hawaiian bottomfish fisheries actually represents two distinct fishing regions, the Main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands (NWHI). These regions subdivided into areas as defined on the HDAR Fisheries Charts (Figure 2 and 3, Table 1). The "Other" category in some of the tables represents areas not defined on Table 1.

The HDAR's database lacks zero-catch trip data, thus estimates of catch per unit effort (CPUE) are artificially high. However, relative CPUE, such as pounds caught per reported day or trip are used as indicators of fishery performance. Several methods of generating relative CPUE were examined. The method used in this report calculates CPUE by dividing the actual number of a particular species caught by the number of records which catches were reported.

Fisheries data collected by the Honolulu Lab, in conjunction with the Council is also presented in this report. This data was collected by monitoring Hawaii's wholesale fish market (See Appendix C for details). Discrepancies in harvest estimates exist between the two data sets. These differences are the result of the different sampling methods used to obtain the data and will be addressed in later sections.

I. FISHERIES PERFORMANCE DATA

1. Total Landings by Species by Area By Month

Total landings (reported in pounds) are given by area by month in Table 2 for 1985 and Table 3 for 1986. This is further broken down into total catch by species and area for both years in Appendix A. According to the HDAR data, bottomfish fisheries in the Main Hawaiian Islands landed 70.1% of the total landings of bottomfish reported in 1985 and 71.3% of the landings in 1986.

DEPARTMENT OF LAND AND
NATURAL RESOURCES

FISH CATCH REPORT

DIVISION OF AQUATIC RESOURCES
STATE OF HAWAII

1. Name of Licensee JOHN SMITH 2. Commercial Marine License No. 85-4567
 3. Name of Boat SMITHY I 4. HA No. HA-1342-CF 5. Federal No.
 6. Month Fished April 7. Year Fished - 19 85 ☐ Place an "X" in the box if you did not fish.

8. Day Fished	9. Area Fished	10. Type of Fishing Gear Used	11. Species Caught	12. No. Caught	13. Lbs. Caught	14. Lbs. Sold	15. Value of Lbs. Sold	16. Port of Landing
1	331	handline	Opaka paka	7	51	51	171 40	Kaunalo
"	"	"	Ehu	4	13	13	36 27	"
"	"	"	Onaga	12	101	101	370 00	"
4	429	handline	Opaka paka	6	49	49	159 00	Kaunalo
"	"	"	Kakikale	2	6	6	12 84	"
"	409	"	Taape	21	15	15	15 00	"
5	422	handline	Ehu	15	41	41	115 00	Waimanalo
"	"	"	Onaga	9	79	79	276 50	"
"	"	"	Hanapepe	5	12	12	21 00	"
10	422	handline	None	-	-	-	-	-
14	423	handline	Uku	11	56	56	168 00	Waimanalo
"	"	"	White uku	2	32	32	32 00	"
"	"	"	Kakala	5	45	0	-	"
"	"	"	Taape	47	33	33	24 75	"
18	331	handline	Opaka paka	23	104	104	337 50	Kaunalo
"	"	"	Gindai	4	10	10	25 00	"
"	"	"	Onaga	8	60	60	210 00	"
19	331	"	Opaka paka	19	94	94	321 27	"
"	"	"	Lahi	3	5	5	12 50	"
"	"	"	Kakikale	7	11	11	22 00	"
25	420	"	Opaka paka	11	21	21	57 75	Kaunalo

FOR OFFICE USE

LOGGED _____
 EDITED _____
 CODED _____
 SUBMIT _____

The above report is true, correct, and complete to the best of my knowledge and belief.

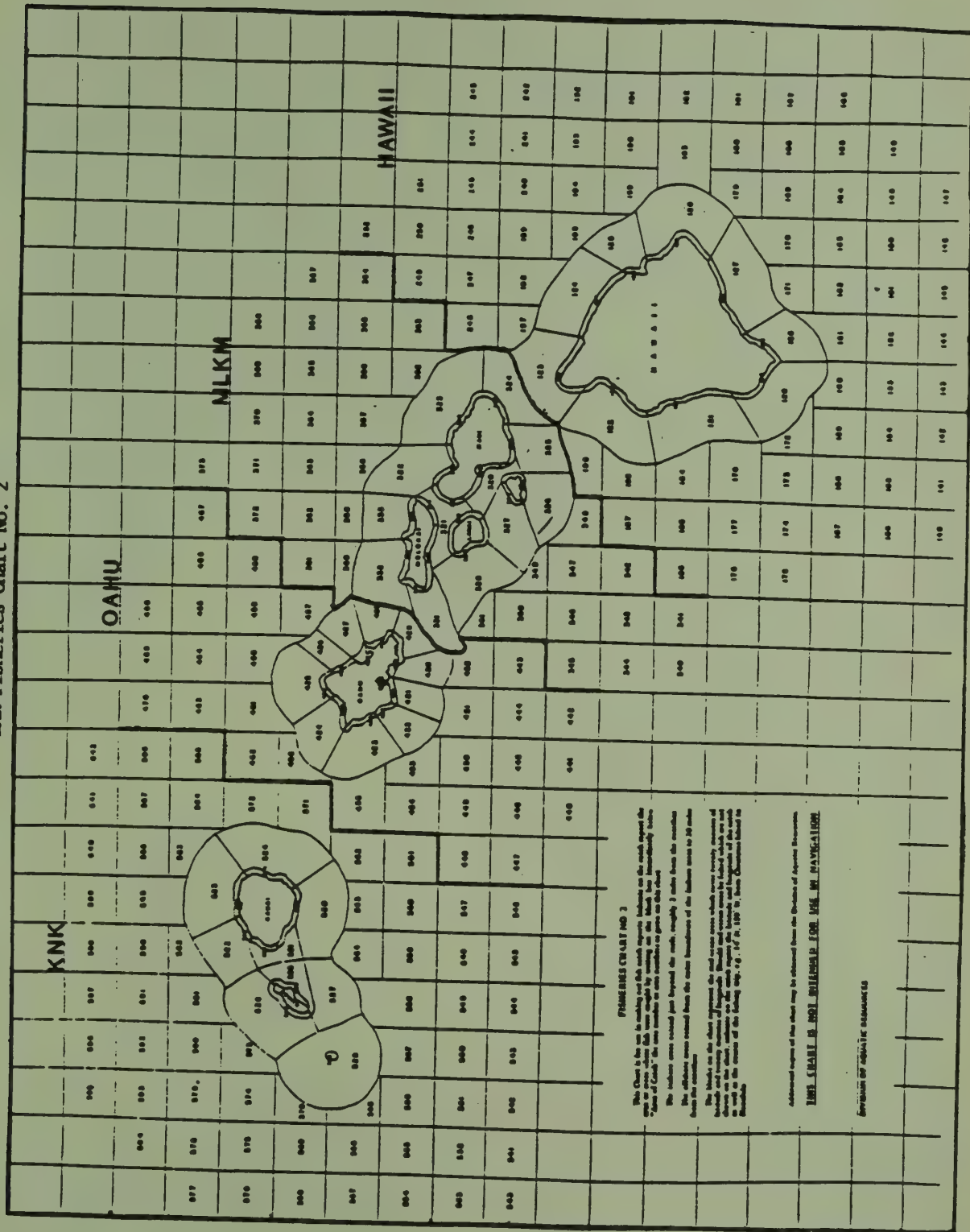
17. Signature John Smith
 Licensee or Authorized Agent

See instructions on Page 1

C-3 (Rev. 3/1/84)

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FIGURE 2. MAIN HAWAIIAN ISLANDS
DAR Fisheries Chart No. 2



DAR Fisheries Chart No. 3

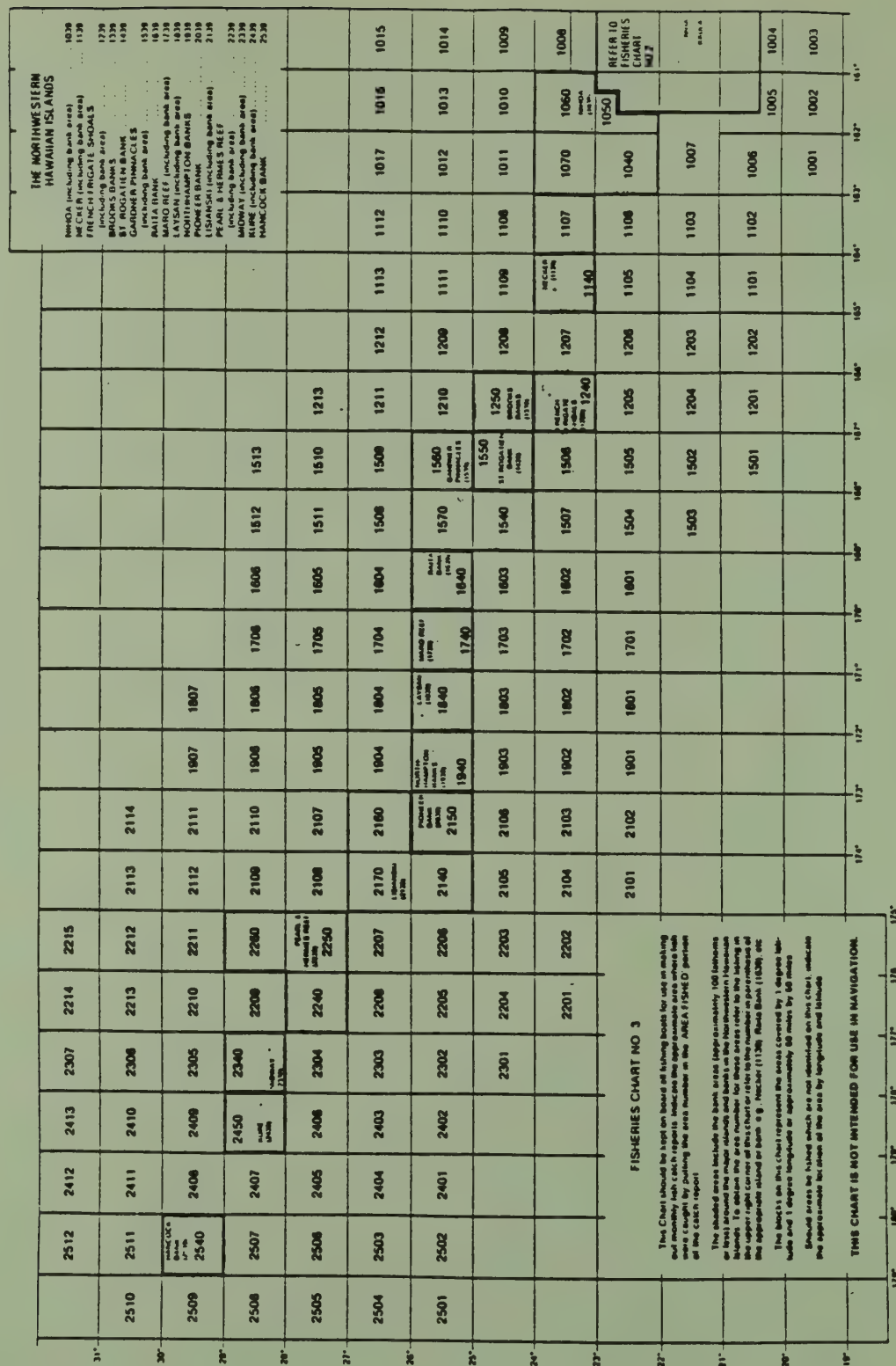
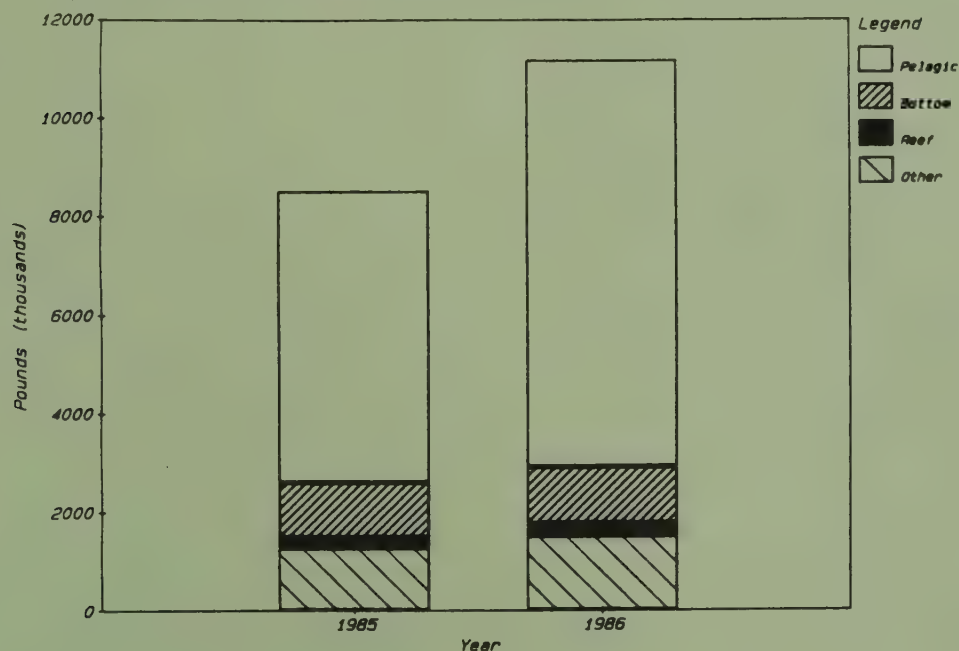


TABLE 1. HAWAIIAN BOTTOMFISHING AREAS AND ZONES.

ZONES	AREA	STATISTICAL AREAS
<u>MAIN HAWAIIAN ISLANDS</u>		HDAR Fisheries Chart No. 2
	Hawaii	100 to 299
	MLKM (Maui, Lanai, Kahoolawe, Molokai, Penguin Bank)	300 to 399
	Oahu	400 to 499
	KNK (Kauai, Niihau, Kaula)	500 to 699
<u>NORTHWESTERN HAWAIIAN ISLANDS</u>		HDAR Fisheries Chart No. 3
	Niihoa Island	1039, 1040, 1050, 1060, 1070
	Twin Banks	1107
	Necker Island	1139, 1140
	French Frigate Shoals	1239, 1240
	Brooks Banks	1339, 1250
	St. Rogatien Bank	1439, 1550
	Gardner Pinnacles	1539, 1540, 1560, 1570
	Raita Bank	1639, 1640
	Maro Reef	1739, 1740
	Laysan Island	1839, 1840
	Northhampton Banks	1939, 1940
	Pioneer Bank	2039, 2150
	Lisianski Island	2139, 2140, 2160, 2170
	Pearl and Hermes Reef	2239, 2240, 2250, 2260
	Midway Islands	2339, 2340
	Kure Atoll	2439, 2450
	Hancock Seamount	2539, 2540
OTHER		999 or other undefined code

FIGURE 4. ANNUAL TRENDS IN FISHERIES TYPES IN THE HAWAIIAN ISLANDS FOR 1985 AND 1986.



Landings were high in January, February, November and December of 1985. In 1986, bottomfish landings were high in January, September, October and December. Bottomfish catches were high in all areas of the MHI (Hawaii, Maui, Lanai, Kahoolawe, Molokai (MLKM), Oahu and Kauai, Niihau, Kaula (KNK), Table 1), although Oahu was the lowest among the MHI areas in both years. The National Marine Fisheries Service, Honolulu Lab estimated that the MHI accounted for only 58% of the landings in 1984, 46% of the commercial landings in 1985 and 49% of the commercial landings in 1986.

The HDAR data indicated that the Northwestern Hawaiian Islands fisheries accounted for 26.5% of the total commercial landings in 1985 and 28.1% of the landings in 1986. The Honolulu Lab estimated that the landings from the NWHI made up 42% of the State's landings in 1984, 54% of the landings in 1985 and 51% of the landings in 1986. These fisheries did not fluctuate as greatly on an annual basis, but was obviously lower in March, April and May in 1985 (Table 2) and lower during February, April, May and June in 1986 (Table 3). Bottomfish catches of the NWHI were primarily from the areas of Necker, Twin and Northhampton in 1985 and from Necker, Raita, Northhampton and Lisianski in 1986. This shift in fishing areas represents a northwesterly movement of NWHI fishermen. The significance of this is expanded on under the biological indicators section of this report.

2. Estimated Ex-vessel Revenues by Species

The number of pounds sold and ex-vessel revenues for 1985 and 1986 are reported by HDAR for the MHI and the NWHI combined by species (Table 4). In 1985, opakapaka was the species which accounted for the most pounds sold (291,919 lbs) and revenue generated (\$946,993.92), followed by onaga with 232,468 lbs sold and \$839,852.16 generated from the sales. The other important species on the commercial market in 1985 were ehu with \$181,884.39 generated, hapuupuu with \$160,638.32 generated and uku with \$152,534.84 generated from the sale of this bottomfish species. In 1986, opakapaka still accounted for the most ex-vessel revenues with 288,463 lbs sold and \$922,732.21 generated. Onaga ran second in 1986 with 235,284 lbs sold and \$867,228.95 revenues. Other important species in 1986 include uku with \$289,031.67 generated, hapuupuu with \$164,015.94 generated and ulua with \$127,582.69 generated from the commercial sale of these species. A detailed economic analysis of the Hawaiian bottomfish fisheries is presented in Appendix B.

3. Fishing effort information

A. Number of vessels, number of trips, days fished and landings per trip

The number of active fishing vessels in the NWHI

TABLE 2. TOTAL CATCH IN POUNDS BY AREA AND MONTH FOR 1985

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HAWAII	26487	14790	2969	8893	8372	15429	9014	15036	13111	14046	37069	31453
MLKM	41641	30724	4022	14504	10707	20253	13174	18690	32290	21206	55174	60841
OAHU	11154	7365	1181	2652	1862	3577	6455	4782	8685	5904	4766	10043
KMK	34929	31948	8112	15366	4266	9872	4301	14849	10030	6566	11300	23944
TOTAL												
MHI	114211	84827	16257	41415	25207	49131	32944	53357	64116	47717	98309	126281
NIHOA	.	.	.	.	.	.	.	.	.	.	.	1702
TWIN	.	.	.	13689	5834	5255	10449	6016	.	.	.	.
NECKER	13906	16048	5941	3200	.	5722	931	.	1336	2827	16091	11488
FRIGATE	8657	365	.	.	.	.	.	.	287	.	.	.
BROOKS	.	4838	.	1050	.	.	.	82	.	14125	.	.
ROGATIEN	.	.	.	.	.	.	.	.	.	.	6985	.
GARDNER	.	.	.	.	.	.	.	.	4693	.	.	.
RAITA	.	.	.	.	.	.	.	5205	566	430	.	.
MARO	.	.	.	.	.	.	.	.	7945	.	.	4725
LAYSAN	.	.	.	.	.	.	.	.	.	.	.	.
NORTHHAM	.	.	.	.	9252	9273	26295	10482	14058	3903	14088	8544
TOTAL												
NWHI	22563	21251	5941	17939	15086	20250	37675	21785	28885	21285	49545	26459
OTHER	8240	9327	1122	1492	2487	2855	1090	.	150	777	5977	3569

TABLE 3. TOTAL CATCH IN POUNDS BY AREA AND MONTH FOR 1986

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HAWAII	25591	18164	18978	9092	11221	6210	12630	8079	13817	13217	9126	29063
MLKM	48456	27971	18885	6768	19228	15249	20206	22421	40736	34606	26981	58106
OAHU	10696	4869	4427	5566	11150	4627	5525	3713	13264	10345	10498	16510
KMK	19809	14051	3590	2043	15718	4049	15184	27474	31084	22406	11134	26679
TOTAL												
MHI	104552	65055	45880	23469	57317	30135	53545	61687	98901	80574	57739	130358
NIHOA	1092	.	2534	4683	3836	1402	373	3085	1233	2534	.	.
TWIN	.	514	.	.	.	.	.	693	.	.	.	.
NECKER	8801	6420	3463	.	293	1445	2522	6344	1413	857	412	.
FRIGATE	8900	.	1031	2272	9831	9263	19415	14666	15134	11399	.	8148
BROOKS	8320	.	5709	.	.	.	.	.	1363	1704	156	4617
ROGATIEN	2429	.	.	.	.	.	.	.	276	.	5129	.
GARDNER	.	.	.	.	.	475	4947	.	.	750	750	.
RAITA	.	.	5144	3678	.	630	872	10837	7552	.	16063	.
MARO	.	.	17	.	.	976	1061	3480	2750	.	.	.
LAYSAN	.	.	.	.	.	.	.	1216	110	.	.	.
NORTHHAM	9710	1401	4470	3820	.	216	.	.	.	8222	.	.
PIONEER	.	.	.	.	.	.	.	.	.	8679	9538	.
LISIANSKI	.	.	.	.	.	3705	.	.	7668	4729	.	11058
TOTAL												
NWHI	39252	8335	22368	14903	13960	18112	29190	40321	37499	38874	32048	23823
OTHER	263	3545	674	.	.	503	1825	.	.	117	.	.

TABLE 4. POUNDS SOLD AND EX-VESSEL REVENUES IN 1985 AND 1986
(BASED ON HDAR REPORTS).

Species	Pounds Sold	Revenue	\$/Pound
1985			
Hapuupuu	98,000	\$160,683.32	1.64
Kahala	34,393	\$ 24,633.41	0.72
Kalekale	26,655	\$ 56,919.68	2.14
Opakapaka	291,919	\$946,993.92	3.24
Uku	52,522	\$152,534.84	2.90
Ehu	65,221	\$181,884.39	2.79
Onaga	232,468	\$839,852.16	3.61
"Ulua"	48,654	\$ 92,725.67	1.91
Lehi	28,578	\$ 75,757.10	2.65
Gindai	6,834	\$ 14,341.17	2.10
Taape	55,502	\$ 43,249.78	0.78
Butaguchi	51,295	\$ 43,961.30	0.86
White/Black Ulua	32,217	\$ 33,326.88	1.03
1986			
Hapuupuu	102,639	\$164,015.94	1.60
Kahala	23,641	\$ 12,493.56	0.53
Kalekale	22,017	\$ 43,664.40	1.98
Opakapaka	288,463	\$922,732.21	3.20
Uku	103,990	\$289,031.67	2.78
Ehu	57,119	\$161,626.80	2.83
Onaga	235,284	\$867,228.95	3.69
"Ulua"*	77,854	\$127,582.69	1.64
Lehi	21,604	\$ 59,982.77	2.78
Gindai	5,022	\$ 11,184.09	2.23
Taape	50,613	\$ 41,245.42	0.81
Butaguchi	71,901	\$ 77,713.76	1.08
White/Black Ulua	18,340	\$ 35,402.11	1.93

* - The total reported catch for "ulua" from the HDAR 1986 summary is 83,342 pounds. The computer generated analysis shows that 84,574 pounds of "ulua" were caught. No explanation for this discrepancy has been found yet.

TABLE 5. TOTAL CATCH, EFFORT*, AND CPUE BY SPECIES IN 1985

SPECIES	ZONE	CATCH	EFFORT	CPUE
HAPUUPUU	MAIN ISLANDS	29055	891	32.61
KAHALA	MAIN ISLANDS	39967	1016	39.34
KALEKALE	MAIN ISLANDS	25837	1832	14.17
OPAKAPAKA	MAIN ISLANDS	174746	4133	42.28
UKU	MAIN ISLANDS	49264	1259	39.13
EHU	MAIN ISLANDS	10918	98	111.41
ONAGA	MAIN ISLANDS	218552	2935	74.46
"ULUA"	MAIN ISLANDS	62148	2740	22.68
LEHI	MAIN ISLANDS	30851	1115	27.67
GINDAI	MAIN ISLANDS	4346	707	6.15
TAAPE	MAIN ISLANDS	59093	2137	27.65
BUTAGUCHI	MAIN ISLANDS	4035	44	91.70
W/B ULUA	MAIN ISLANDS	9871	229	43.10
HAPUUPUU	NW ISLANDS	59896	133	450.35
KAHALA	NW ISLANDS	519	8	64.88
KALEKALE	NW ISLANDS	2551	66	38.65
OPAKAPAKA	NW ISLANDS	116462	163	714.49
UKU	NW ISLANDS	598	20	29.90
EHU	NW ISLANDS	10918	98	111.41
ONAGA	NW ISLANDS	16688	45	370.84
"ULUA"	NW ISLANDS	10347	72	143.71
LEHI	NW ISLANDS	8	1	8.00
GINDAI	NW ISLANDS	2736	70	39.09
TAAPE	NW ISLANDS	411	6	68.50
BUTAGUCHI	NW ISLANDS	44508	92	483.78
W/B ULUA	NW ISLANDS	23022	17	1354.24
HAPUUPUU	OTHER	9938	7	1419.71
KAHALA	OTHER	88	4	22.00
KALEKALE	OTHER	284	12	23.67
OPKAPAKA	OTHER	12310	26	473.46
UKU	OTHER	4869	8	608.63
EHU	OTHER	2143	13	164.85
ONAGA	OTHER	4295	11	390.45
"ULUA"	OTHER	141	9	15.67
LEHI	OTHER	12	2	6.00
GINDAI	OTHER	101	3	33.67
TAAPE	OTHER	96	9	10.67
BUTAGUCHI	OTHER	2809	4	702.25

* - Number of records a particular species was caught.

TABLE 6. TOTAL CATCH, EFFORT*, AND CPUE BY SPECIES IN 1986
(BASED ON HDAR REPORTS).

SPECIES	ZONE	CATCH (# OF FISH)	EFFORT	CPUE
HAPUUPUU	MAIN ISLANDS	31626	643	49.19
KAHALA	MAIN ISLANDS	38380	804	47.74
KALEKALE	MAIN ISLANDS	20370	1216	16.75
OPAKAPAKA	MAIN ISLANDS	202460	3772	53.67
UKU	MAIN ISLANDS	104047	1653	62.94
EHU	MAIN ISLANDS	50251	2257	22.26
ONAGA	MAIN ISLANDS	167112	2492	67.06
"ULUA"	MAIN ISLANDS	81540	3333	24.46
LEHI	MAIN ISLANDS	23056	762	30.26
GINDAI	MAIN ISLANDS	2692	431	6.25
TAAPE	MAIN ISLANDS	53481	1747	30.61
BUTAGUCHI	MAIN ISLANDS	19419	83	233.96
W/B ULUA	MAIN ISLANDS	14778	235	62.89
HAPUUPUU	NW ISLANDS	70110	202	347.08
KAHALA	NW ISLANDS	89	5	17.80
KALEKALE	NW ISLANDS	2840	67	42.39
OPAKAPAKA	NW ISLANDS	101273	183	553.40
UKU	NW ISLANDS	2446	16	152.88
EHU	NW ISLANDS	9429	130	72.53
ONAGA	NW ISLANDS	71545	104	687.93
"ULUA"	NW ISLANDS	3020	51	59.22
GINDAI	NW ISLANDS	2498	72	34.69
TAAPE	NW ISLANDS	4	2	2.00
BUTAGUCHI	NW ISLANDS	51153	122	419.29
W/B ULUA	NW ISLANDS	3828	6	638.00
HAPUUPUU	OTHER	1721	4	430.25
KAHALA	OTHER	25	2	12.50
KALEKALE	OTHER	124	5	24.80
OPAKAPAKA	OTHER	1494	9	166.00
UKU	OTHER	19	1	19.00
EHU	OTHER	593	8	74.13
ONAGA	OTHER	894	5	178.80
"ULUA"	OTHER	14	2	7.00
GINDAI	OTHER	61	3	20.33
BUTAGUCHI	OTHER	1777	3	592.33
W/B ULUA	OTHER	205	1	205.00

* - Number of records a particular species was caught.

bottomfishery has grown from 20 in 1984 to 29 in 1986. The number of active fishing vessels in the MHI is not available.

The number of estimated (by HDAR) bottomfishing trips in 1985 and 1986 roughly corresponds to the effort reported in Table 5 and Table 6. This figure is the number of records from the HDAR Fish Catch Reports (Figure 1) which listed a particular species. In other words, effort designates the number of fishing trips on which a particular species was caught. In 1985, fishing effort by species was 44 to 4133 fishing trips in the Main Hawaiian Islands and from 1 to 163 fishing trips for a species in the Northwestern Hawaiian Islands. In 1986, fishing effort by species was 83 to 3772 for the MHI and 6 to 202 fishing trips reported for the NWHI. From this data, it appears that the Main Hawaiian Islands received more fishing trips than the Northwestern Hawaiian Islands in both years. This conclusion could be an artifact of fishing trip duration because effort is defined on a per trip basis. Since fishing trips are generally shorter in the MHI than in the NWHI, there will be more trips reported in the MHI (not necessarily more fishing effort).

The exact number of days fished in the fishing regions of the Hawaiian Islands is not presented in this report, but will be addressed in future annual bottomfishing reports.

The number of landings per trip is given by the CPUE (catch per unit effort, Table 5 and 6). This number is calculated by dividing the catch by the effort (number of records (trips) which a species was reportedly caught). This figure represents an overestimate of the catch per trip (by species) because zero-catch trip data are not included in these calculations.

Relative CPUE (estimated from HDAR data) was lower for the MHIs than in the NWHI for both years. In the MHI, CPUE increased in 1986 for all species except onaga and ulua (See Tables 5 and 6). In the NWHI, relative CPUE generally decreased slightly for many species between 1985 and 1986. This trend was not noted for onaga, uku and kalekale which has a higher CPUE in 1986.

B. Species composition of landings, areas fished, catch per day by area, and other indicators of fishery performance

The species composition of landings (from HDAR data) varied both between areas within a zone and also between years (1985 and 1986). Because these differences exist between areas, species composition of areas (MHI and NWHI) is reported. In the MHI, the relative proportions of species caught changed between 1985 and 1986 (Table 7 and 8). The biggest changes occurred in the Hawaii area; in 1985 onaga was the second most common species caught, followed by kahala. In 1986, uku was the second most common species and onaga ran third. The absolute numbers of landings per area are given in Appendix A. Overall in the MHI,

TABLE 7. SPECIES COMPOSITION OF 1985 BOTTOMFISH LANDINGS IN THE HAWAIIAN ISLANDS BY AREA. PROPORTION OF CATCH GIVEN BELOW THE NAME.

AREA	SPECIES 1	SPECIES 2	SPECIES 3	SPECIES 4	SPECIES 5	SPECIES 6
Main Hawaiian Islands						
Hawaii	Opakapaka	Onaga	Kahala	Ehu	Ulua	Taape
MLKM	.235	.145	.137	.112	.086	.081
	Onaga	Opakapaka	Uku	Ulua	Ehu	Lehi
	.352	.299	.094	.065	.060	.050
Oahu	Taape	Opakapaka	Ulua	Onaga	Uku	Ehu
	.229	.224	.200	.145	.057	.031
Northwestern Hawaiian Islands						
Nihoa	Opakapaka	Hapuupuu	Ehu	Kalekale	Gindai	Ulua
	.459	.219	.103	.063	.062	.044
Twin	Opakapaka	Hapuupuu	Butaguchi	Ehu	Onaga	Kalekale
	.483	.333	.076	.065	.014	.013
Necker	Opakapaka	Hapuupuu	Butaguchi	Ehu	Onaga	Gindai
	.441	.308	.121	.040	.038	.012
Frigate	Opakapaka	Hapuupuu	Butaguchi	Ulua	Uku	Taape
	.781	.099	.091	.014	.009	.006
Brooks	Opakapaka	Hapuupuu	Butaguchi	Ehu	Onaga	W/B Ulua
	.390	.222	.163	.072	.070	.038
Rogatien	Hapuupuu	Opakapaka	Ehu	Butaguchi	Onaga	Gindai
	.337	.304	.138	.104	.063	.032
Gardner	Opakapaka	Butaguchi	Hapuupuu	Kahala	Ulua	Gindai
	.448	.290	.186	.039	.019	.011
Raita	Ulua	Hapuupuu	Butaguchi	Opakapaka	Kahala	Kalekale
	.474	.240	.116	.094	.050	.016
Maro	Opakapaka	Butaguchi	Hapuupuu	Onaga	Gindai	Ulua
	.378	.275	.270	.057	.015	.005

TABLE 8. SPECIES COMPOSITION OF 1986 BOTTOMFISH LANDINGS IN THE HAWAIIAN ISLANDS BY AREA. PROPORTION OF CATCH GIVEN BELOW THE NAME.

AREA	SPECIES 1	SPECIES 2	SPECIES 3	SPECIES 4	SPECIES 5	SPECIES 6
Main Hawaiian Islands						
Hawaii	Opakapaka .260	Uku .128	Onaga .117	Kahala .110	Taape .108	Ehu .101
MLKM	Opakapaka .291	Onaga .232	Uku .100	Ulua .055	Ehu .044	Lehi .034
Oahu	Taape .214	Ulua .195	Onaga .181	Opakapaka .167	Uku .076	W/B Ulua .058
Northwestern Hawaiian Islands						
Nihoa	Hapuupuu .376	Onaga .167	Opakapaka .161	Butaguchi .132	Ehu .069	Kalekale .055
Twin	Opakapaka .258	Onaga .230	Hapuupuu .215	Ehu .188	Butaguchi .079	Ulua .028
Necker	Hapuupuu .265	Onaga .262	Opakapaka .187	Butaguchi .171	Ehu .051	Uku .031
Frigate	Onaga .434	Opakapaka .312	Butaguchi .123	Hapuupuu .091	Ehu .019	Uku .008
Brooks	Opakapaka .354	Onaga .295	Hapuupuu .199	Butaguchi .088	Ehu .024	Uku .023
Rogatien	Opakapaka .320	Hapuupuu .259	Onaga .222	Butaguchi .190	Kalekale .007	Ehu .001
Gardner	Opakapaka .581	Onaga .173	Butaguchi .135	Hapuupuu .111	.	.
Raita	Opakapaka .461	Hapuupuu .277	Butaguchi .184	W/B Ulua .033	Ulua .014	Ehu .012
Maro	Butaguchi .597	Opakapaka .302	Hapuupuu .089	Ehu .006	Gindai .004	Kalekale .002
Laysan	Hapuupuu .464	Ehu .283	Butaguchi .181	Onaga .026	Kalekale .026	Opakapaka .012
Northham	Opakapaka .314	Butaguchi .292	Hapuupuu .236	Onaga .106	Ulua .025	Ehu .011
Pioneer	Hapuupuu .508	Butaguchi .159	Onaga .124	Opakapaka .124	Ehu .056	Gindai .024
Lisian.	Opakapaka .441	Hapuupuu .286	W/B Ulua .086	Butaguchi .065	Ehu .052	Onaga .039

FIGURE 5A. MANAGEMENT UNIT SPECIES CATCH TOTALS FOR THE MAIN HAWAIIAN ISLANDS IN 1985.

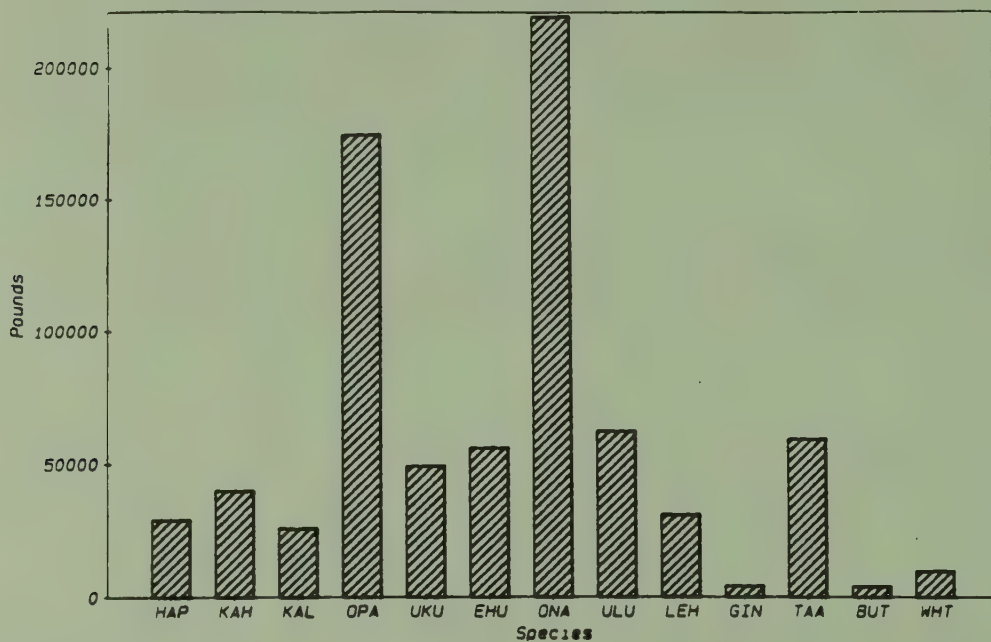


FIGURE 5B. MANAGEMENT UNIT SPECIES CATCH TOTALS FOR THE MAIN HAWAIIAN ISLANDS IN 1986.

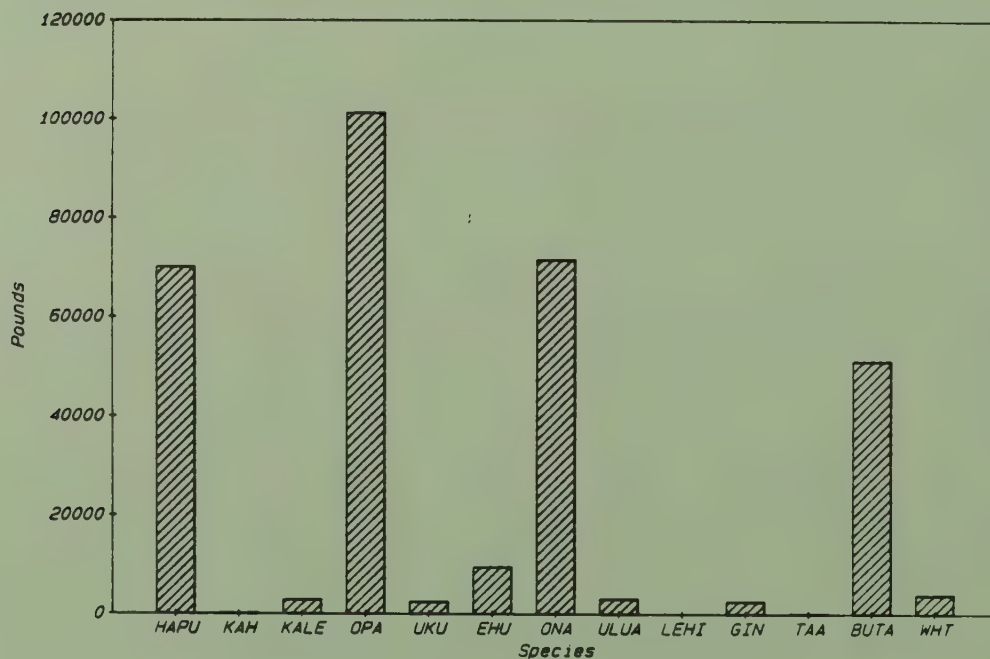


FIGURE 6. MANAGEMENT UNIT SPECIES CATCH TOTALS FOR THE NORTHWESTERN HAWAIIAN ISLANDS IN 1985.

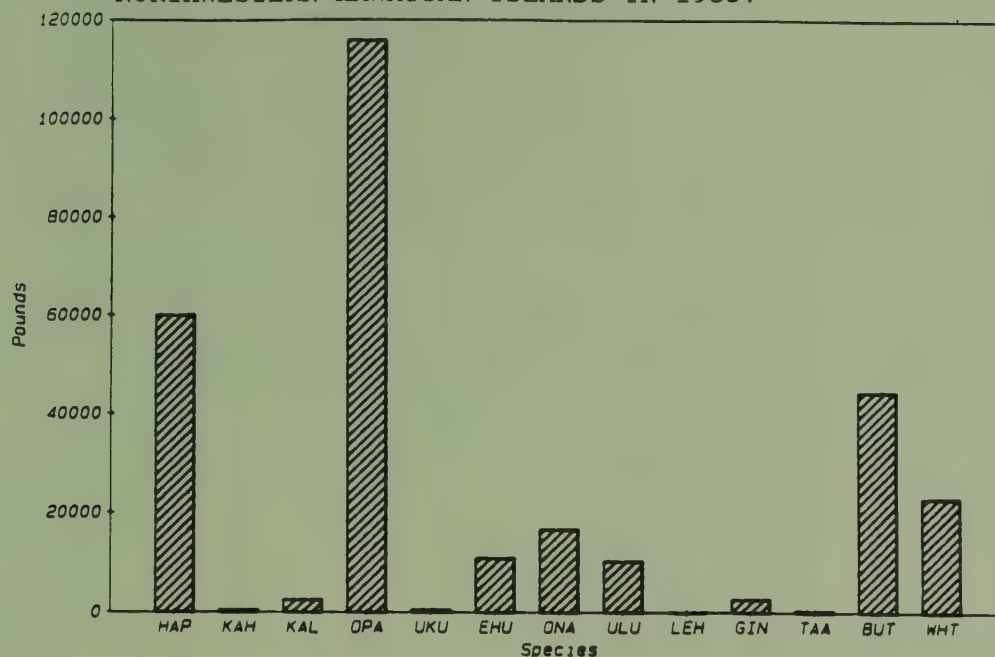
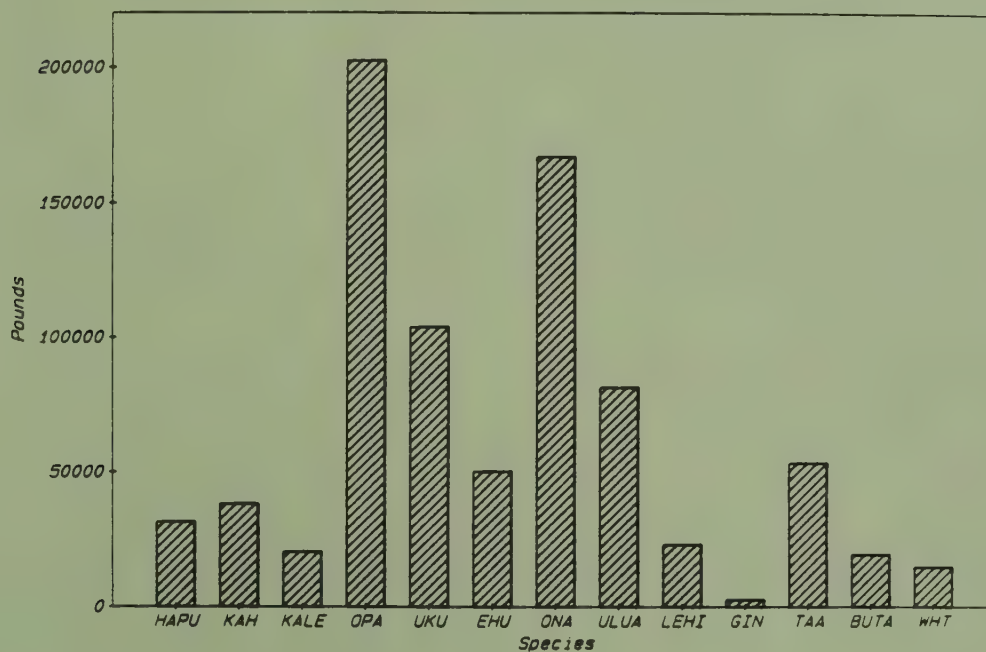


FIGURE 7. MANAGEMENT UNIT SPECIES CATCH TOTALS FOR THE NORTHWESTERN HAWAIIAN ISLANDS IN 1986.



onaga decreased dramatically in 1986. This is discussed further under biologic characteristics (See Section 4, pg 12).

In the NWHI, opakapaka, hapuupuu, onaga and butaguchi were the most important components of the landings in both 1985 and 1986 (according to HDAR data). Changes in species composition were also apparent in the NWHI between 1985 and 1986 (Table 7 and Table 8). Almost every area differed between years in the 3 most common species represented. Overall, onaga increased in importance in many areas, along with hapuupuu (Figures 6 and 7). Opakapaka and ulua decreased in importance in 1986 in the NWHI.

The areas fished are outlined in the introduction to this section. Total bottomfish catch (in lbs, based on HDAR data) by area is listed below to indicate which areas are more important in the Hawaiian commercial bottomfish fishery.

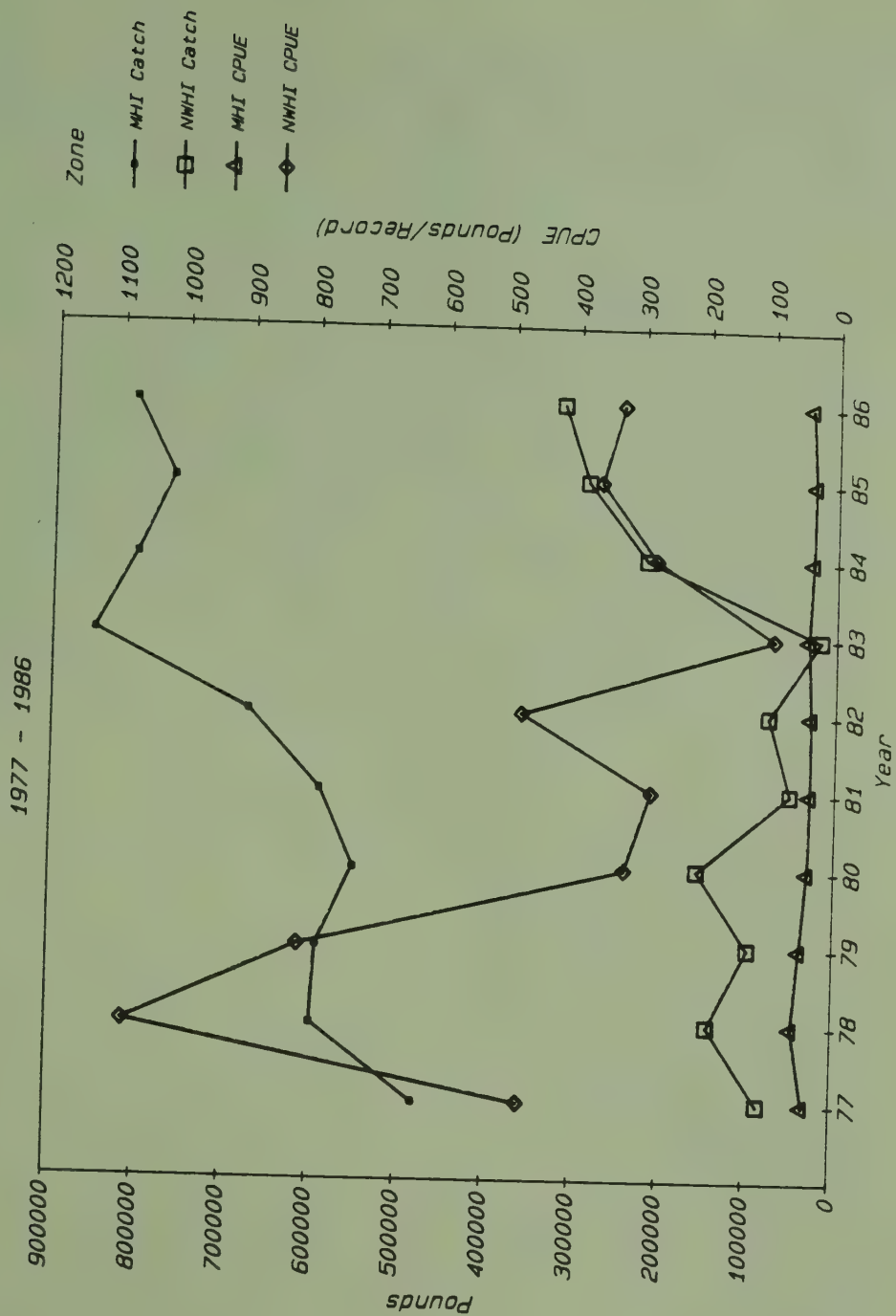
MHI			NWHI		
Area	1985 Landings	1986 Landings	Area	1985 Landings	1986 Landings
Hawaii	196669	175188	Nihoa	1702	20772
MLKM	323226	339613	Twin	41243	1207
Oahu	68426	101190	Necker	77490	31970
KMK	175483	193221	Frigate	9309	100059
			Brooks	20095	21869
			Rogatien	6985	7834
			Gardner	4693	6922
			Raita	6201	44776
			Maro	12670	8284
			Laysan	14088	1326
			Northh.	94188	27839
			Pioneer	.	18217
			Lisianski	.	27160

The National Marine Fisheries Service, Honolulu Lab, found that in 1986, Lisianski received 15% of the fishing trips in the NWHI, followed by Necker which accounted for 8% of the trips, then Gardner (7%), Nihoa (6%), and Laysan, Frigate and Pioneer which all received 4% of the fishing trips.

Information on catch per day by area is not provided in this report but will be provided in Appendixes in future reports.

Other indicators of fishery performance include general trends in total catch and relative catch per unit effort (CPUE) between 1977 and 1986 (Figure 8, based on HDAR data). Total catch in the MHI has shown a general increasing trend during this period from roughly 480,000 lbs to 830,000 lbs. On the other hand, relative CPUE for the MHI has remained fairly constant and

FIGURE 8. TOTAL CATCH AND RELATIVE CPUE FOR THE HAWAIIAN ISLANDS BY YEAR
AND BY ZONE.



bottomfishery landings increased to 784,000 lbs. in 1986, see Appendix B). Lowest total catch in the NWHI occurred in 1983. CPUE has fluctuated tremendously, reaching a high in 1978. Between 1977 and 1986, the relative CPUE of the NWHI decreased but always remained higher than the relative CPUE of the MHI.

4. Biological Characteristics of the Landings

The results presented below are taken from a detailed report (Appendix C) prepared by the National Marine Fisheries, Honolulu Lab. This report analyzes a variety of biological factors and fishery performance indicators for both the Main Hawaiian Islands and the Northwestern Hawaiian Islands in order to gain some insights into the status of the Hawaiian bottomfish fisheries. Data on commercial landings was obtained from the centralized wholesale fish market in Honolulu. Thus, the catch numbers reported do not represent absolute totals but are considered to be indicative of the fishery as a whole (in terms of size-structure of landings, weight of landings, etc).

Seven species dominated the Hawaiian bottomfish market. These were opakapaka, onaga, ehu, uku, hapuupuu, butaguchi and ulua. In particular, opakapaka has been the "mainstay" of the bottomfish fishery in Hawaii. Onaga was the second most important commercial species and hapuupuu was third in importance.

In the MHI, landings have remained stable between 1984 and 1986, although some evidence exists that the fishery is being overexploited. Analysis of the size-structure of opakapaka indicates that the (modal) size of landings has decreased from 1.36 kg (3 lb) in 1984 to 0.91 kg (2 lb) in 1985 and 1986. Additionally, the age of entry to the fishery of opakapaka has dropped substantially over the past 3 years. The HL report suggests that if current trends continue, the yield per recruit of opakapaka will decline.

Onaga are also entering the fishery at a very small size. Unlike opakapaka, the length-frequency data provided no indication of high mortality rates. Onaga is probably under light exploitation and no biological evidence exists to suggest that onaga is being overexploited in the MHI.

The age at entry to the fisheries for ehu was very low in the MHI. Other biological evidence, such as the yield per recruitment analysis indicated that the ehu fishery was overexploited in this zone. The uku fishery also showed signs of overexploitation, although the age at entry to the fishery was greater than for other species. Evidence of overexploitation came from length-frequency analyses.

The hapuupuu fishery of the MHI has not been overfished between 1984 and 1986. The weight at entry into the fisheries was not extremely high, but neither was the estimated fishing mortality. The current age at entry into the fishery was near optimal.

Overall the MHI fishery conditions have been fairly stable from 1984 to 1986. There is evidence of growth-overfishing (overfishing which results from harvesting at a small size, see Glossary) for 3 of the 5 species examined (opakapaka, ehu and uku). An increase in the age at entry into the fisheries would benefit these 3 species. The condition of hapuupuu and onaga stocks appeared to be much better. Relatively speaking, large onaga were plentiful in the Main Hawaiian Islands and there was some justification for the encouragement of further exploitation.

In the Northwestern Hawaiian Islands, the fishery has been everything but stable and landings have increased 43 percent overall. Despite this increase, opakapaka landings have decreased between 1984 and 1986. Indications of a lessening of fishing mortality and an increase in the age at entry were found for this species. This change in the opakapaka fishery was probably a function of the change in fishing grounds to relatively unexploited grounds in 1985 and 1986.

Catches of onaga increased between 1984 and 1986. Results of the HL study indicated that onaga entered the fishery at a very high age (> 6 years) in the NWHI. The onaga fishery is relatively new in the NWHI and is unstable. Ehu and hapuupuu also appear to be underexploited in the NWHI. Ehu are entering the fishery at a weight 3 times that of ehu landed in the MHI.

In 1986, bottomfishing activity in the NWHI has extended much further up the Hawaiian Chain. Significant landings were taken at Gardner Pinnacle, Raita Bank, Maro Reef, Lisianski Island and other more northern areas. These findings demonstrate that the fishing activities in the NWHI have been in a dynamic state of flux. Fishermen have been traveling greater distances up the Hawaiian Islands in order to encounter higher catch rates. This movement of fishing activity makes interpretation of this study difficult. In 1986, overall landings from the NWHI exceeded the best available estimate of the maximum sustainable yield by 18 percent. This record harvest is likely due to the fishing-up of stocks as the fleet moved farther to the northwest. Nevertheless, there is every reason to be concerned about the biological condition of bottomfish stocks in the NWHI. With fishing activity so unstable, the estimation and interpretation of analyses such as Appendix C are compromised. One suggestion which could improve the ability to monitor conditions within this fishery is the precise (bank specific) recording of fishing location by fishermen.

5. Summary Tables of Fishery Status

Status of the Main Hawaiian Island Bottomfish fishery

Problem Condition	Present in Bottomfishery	Comment
1. Age at entry is prereproduction	Yes (opakapaka and ehu) No (Other spp.)	See Appendix C
2. Unacceptable ratio of fish-mortality to natural mortality	Yes (For some spp.)	Borderline for opakapaka High for ehu and uku
3. Catch exceeds maximum sustainable yield	Possibly	See Appendix C
4. Significant decline in CPUE	No	
5. Substantial decline in ex-vessel revenue relative to baseline levels	No	
6. Significant shift in gear, by area	No	
7. Significant change in the frozen/fresh components of catch	No	
8. Unstable pattern of entry/exit to the fishery	No	
9. Per trip costs exceed per trip revenues	No	See Appendix B

Problem Condition	Present in Bottomfishery	Comment
10. Significant decline or increase in total bottom- fish landings	No	
11. Change in species composition of catch	No	
12. Research results indicate pro- blems	Yes	See Appendix C
13. Habitat degradation or environ- mental problems	No	
14. Increased interaction with protected species	No	

Status of the Northwestern Hawaiian Islands Bottomfish Fishery

Problem Condition	Present in Bottomfishery	Comment
1. Age at entry is prereproduction	No	
2. Unacceptable ratio of fish-mortality to natural mortality	No	Data on specific areas is limited
3. Catch exceeds maximum sustainable yield	Yes	See Appendix C
4. Significant decline in CPUE	Yes	On a bank by bank basis, See report by Meyer, 1987, WESTPAC Publ.
5. Substantial decline in ex-vessel revenue relative to baseline levels	Yes	See report by Meyer, 1987, WESTPAC Publ.
6. Significant shift in gear, by area	No	
7. Significant change in the frozen/fresh components of catch	Yes	Freezing is presently being used by vessels at Lisianski Island, Pearl and Hermes Reefs (See Meyer, 1987)
8. Unstable pattern of entry/exit to the fishery	Yes	New entry continues each year and there is an accelerated "churning" effect in the fleet (See Meyer, 1987)
9. Per trip costs exceed per trip revenues	Yes	Fixed plus variable costs exceed revenues (See Appendix B)

Problem Condition	Present in Bottomfishery	Comment
10. Significant decline or increase in total bottom-fish landings	Yes	Significant fluctuations in landings between 1977 and 1986.
11. Change in species composition of catch	Yes	
12. Research results indicate problems	Yes	See Appendix C
13. Habitat degradation or environmental problems	No	
14. Increased interaction with protected species	No	

II. RECENT RESEARCH AND SURVEY RESULTS

The most significant occurrence during the last year with respect to recent bottomfish research and survey results was the publication of the book Tropical Snappers and Groupers: Biology and Fisheries Management, edited by J. J. Polovina and S. Ralston (1987) of the Southwest Fisheries Center, Honolulu Laboratory. The book represents the proceedings of a workshop held in Honolulu during May 1985 and includes 15 chapters prepared by 18 world renowned experts on the title subject. The following is a reproduction of the table of contents:

Chapter	Biological Reviews
1	Systematics of the fishes of the family Lutjanidae (Perciformes:Percoidei), the snappers William D. Anderson, Jr.

- 2 Synopsis of the circumpolar fish genus Lutjanus
 (Lutjanidae)
 Gerald R. Allen
- 3 A preliminary synopsis of the groupers (Perciformes:
 Serranidae:Epinephelinae) of the Indo-Pacific Region
 John E. Randall
- 4 Review of the early life history of tropical groupers
 (Serranidae) and snappers (Lutjanidae)
 Jeffery M. Leis
- 5 Reproductive biology of the Lutjanidae: A review
 Churchill B. Grimes
- 6 Reproduction in groupers
 Douglas Y. Shapiro
- 7 Age and growth of snappers and groupers
 Charles S. Manooch, III
- 8 Mortality rates of snappers and groupers
 Stephen Ralston
- 9 The tropical biology of snappers and groupers
 James D. Parrish

Fishery Management

- 10 Assessment and management of the demersal fishery on
 the continental shelf of northwestern Australia
 Keith J. Sainsbury
- 11 Assessment and management of deepwater bottom fishes in
 Hawaii and the Marianas
 Jeffery J. Polovina
- 12 Development of management plans for reef fishes -- Gulf
 of Mexico and U.S. South Atlantic
 Gene R. Huntsman and James R. Waters
- 13 Reproductive strategies and the management of snappers
 and groupers in the Gulf of Mexico and Caribbean
 Scott P. Bannerot, William W. Fox, Jr., and Joseph E.
 Powers
- 14 Demand considerations in fisheries management --
 Hawaii's market for bottom fish
 Samual G. Pooley

With the information provided in these chapters a solid basis has been established for the management of bottomfish stocks under the Council's jurisdiction. Especially important in this regard are chapters 11 and 14 which relate specifically to these stocks. Moreover the results presented in chapters 4-9 provide comparative biological "truths" concerning these fishes. Armed with this information it is now possible to proceed with basic assessments using only rudimentary size-frequency data (e.g., Ralston and Kawamoto, SWFC Administrative Report H-87-7).

Although there has been no major field program of bottomfish assessment at the Honolulu Laboratory during the last year, the results of the artificial reef study at Penguin Bank relates to the management of these stocks. Preliminary results indicate that deep artificial reefs are effective at aggregating many bottomfish species (e.g., opakapaka and kahala) and that enhanced recruitment can also occur (e.g., taape). A final report has not yet been issued on this research program but should be available in 1987.

Over the last year the Honolulu Laboratory Seamount Resources Program has conducted three survey cruises on the Townsend Cromwell to Southeast Hancock Seamount. Objectives and results of these cruises were discussed in the cruise plans and narrative reports and only highlights of the research results are reported here.

To develop a fisheries-independent assessment tool, the Honolulu Laboratory has been working on a longline-based technique, wherein standardized longlines with hook timers (identifying the time the bait was taken) are deployed. The first cruise to initially test these timers was in August 1986, and again in October 1986. Based on these results, the Seamount Resources Program has planned to begin an annual assessment cruise in late summer each year.

Other research by the Seamount Resources Program has involved continued trawling for biological specimens. Armorhead were more abundant in 1986 than in previous years; this increase was also reported by the Japanese press in an assessment of the northern seamounts. Research on age and growth of armorhead shows that this species recruits to the seamounts at ages from 1.5 to 3 years of age and apparently ceases growth at that point. Large armorhead rarely observed in the NWHI are apparently "strays" which may reach ages of 5-6 years. Research on the morphological changes has confirmed suspicions that the armorhead is a single species, now called Pseudopentaceros wheeleri. Research on the distribution and recruitment has indicated that although recruitment of armorhead continues over extended

periods, there may be peak periods in spring and late summer as shown by seasonal influxes of animals with high condition factor. Future biological research will continue on the feeding ecology of armorhead, the reproductive patterns and limited research on other abundant species at Southeast Hancock Seamount.

Lastly, during the previous year observations concerning the spawning activity of opakapaka (Pristipomoides filamentosus) in the Northwestern Hawaiian Islands were made by Mr. Dane Johnson of the F/V Kawamee and are included here to encourage and promote the input of fishermen into the annual report of the bottomfish monitoring team.

OBSERVATIONS OF OPAKAPAKA SPAWNING BEHAVIOR

Mr. Dane Johnson of the F/V Kawamee reported observations of spawning opakapaka. The event was observed between the April 13-19, 1987 during a commercial bottomfishing trip to the NWHI. These dates roughly coincide with the full moon (04/13/87) and the 6 days subsequent to it.

Observations were made with a chromoscope depth recorder. On the morning of April 13, a large school was located in 67-74 fathoms along a small dropoff in a gently sloping area. The school was contained in an area roughly 1/4 mile long near the dropoff. The F/V Kawamee anchored over the school and opakapaka were caught. Catch rates decreased by mid-morning and the depth recorder showed that the school had compacted closer to the bottom. Over a 1 to 2 hour period, the school became more compacted until the chromoscope could not differentiate between the school of opakapaka and the substrate. Before midday, catches had ceased altogether. During this period, egg masses (reddish-brown in color) were adhering to the fishing gear.

By mid-afternoon, the school became less compacted and dispersed upward into the water column. By evening, catch rates were high again. Observations of the opakapaka during the brining process indicated that some of the fish were in spawning condition. Some females released eggs and some males extruded milt. The daily pattern described above continued through April 16. Free floating eggs were also noted on the ocean surface. The eggs were aggregated and covered a large surface area. The egg slick took many hours to pass the anchored vessel.

Similar observations of schooling behaviors have been made during previous trips also during full moon periods. An egg slick had been reported previously but was not associated with opakapaka specifically.

It is hoped that more of these unusual behavior patterns will be reported in the future. Skipper Dane Johnson has

consented to collect samples of drifting eggs in areas of suspected spawning activity. Samples of this kind may provide proof that the behavior observed was indeed that of spawning opakapaka.

III. HABITAT CONDITIONS AND RECENT ALTERATIONS

Under the Fisheries Management Plan (FMP) regulations were implemented to prohibit the use of bottom trawls, bottom-set nets, explosives and poisons for harvesting bottomfish. This has served to greatly reduce the potential for bottomfish habitat degradation. To our knowledge, there have been no violations of these regulations in 1986.

There are several activities occurring or reportedly occurring in the ECZ which potentially may alter bottomfish habitat. These include:

1. Anchor damage by vessels attempting to maintain position over productive bottomfish habitat.
2. Habitat damage from heavy weights and line entanglement during normal hook-and-line bottomfish operations.
3. Habitat damage by illegal foreign fishing activities for precious corals using coral dredges.

The National Marine Fisheries Service initiated a bottomfish habitat enhancement program in October 1985 when a series of deepwater artificial reefs were placed on the bottom at Penguin Bank. Initial surveys indicate a substantial increase in biomass of bottomfish at these sites. Monitoring of the artificial reefs will continue for at least another two years.

The Honolulu Laboratory Seamount Resources Program is currently working to describe the morphology and physical characteristics of all the seamounts subject to groundfish fishery. A deep-sea camera has been deployed on a recent research cruise, but this gives only point photographs with little habitat information. In August 1987, a remotely operated device, the MANTA, was deployed from the Townsend Cromwell. These results are not available at this time.

The Seamount Resources Program is also conducting research to characterize the ecosystem at Southeast Hancock Seamount. In collaboration with the Naval Postgraduate School and the Pacific Marine Environmental Laboratory, studies of the physical oceanography around the seamount are being conducted. Collaborative work is also being carried out with scientist at the University of Hawaii on the lower trophic levels of the seamounts. These studies will allow a more complete description

of the physical and biological seamount habitats.

IV. ENFORCEMENT ACTIVITIES AND PROBLEMS

There were no reported violations of bottomfish regulations in 1986 requiring actions by NMFS enforcement officers. Enforcement monitoring activities are limited to ensuring vessel compliance with the NWHI permit requirement and prohibitions on the use and possession of destructive fishing gear.

There were no reported incidental takes or fishery interactions with protected species by permitted vessels in 1986.

V. ADMINISTRATIVE ACTIONS AND RECOMMENDATIONS

Regulations implementing the FMP for Bottomfish and Seamount Groundfish Fisheries of the Western Pacific went into effect on August 27, 1986. Among the provisions of the FMP was a requirement that all vessels fishing for bottomfish or seamount groundfish in the Northwestern Hawaiian Islands have a permit issued by the National Marine Fisheries Service.

During the four remaining months of calendar year 1986 a total of 42 vessels were issued a permit for the NWHI bottomfish fishery. Permits issued under the FMP are valid for a one year period from July 1 - June 30. This schedule was selected by the Council in order to coincide with the permit year used by the State of Hawaii. The State of Hawaii is presently reviewing a modification of its permit year issuance period. In addition, the FMP is being amended under a limited access proposal to change permit validity for the NWHI to be effective on a calendar year basis.

All permit holders were advised as a condition of the permit that the permit may be revoked in the event that an access management plan for the NWHI bottomfish fishery is approved and implemented by the Council. In planning for possible access management in the bottomfish fisheries of the western Pacific the Council selected two control dates for the purpose of establishing historic participation in the fishery. August 7, 1985, was selected as the control date for future access to the bottomfish fishery in the NWHI and May 30, 1986, was selected as the control date for access to the bottomfish fisheries of Guam and American Samoa. Notices of these control dates were published in the Federal Register.

VI. STATE MANAGEMENT ACTIONS

As mentioned above, the state is presently considering an adjustment of the fishing permit effective dates.

VII. ASSESSMENT FOR NEED FOR COUNCIL ACTION

The Team reviewed the documents enclosed, and examined a variety of biological and economic indicators, and concluded that there are no developments within the fishery that require immediate management action by the Council.

Given that the Council has advanced the limited access program for the Northwestern Hawaiian Islands (NWHI) bottomfishery, plans are currently underway to relieve some of the problems specific to that region. An issue requiring further study is the apparent discrepancy between NWHI summary statistics obtained from wholesale market data (Appendix C) and from HDAR catch report files (Appendix A).

For the Main Hawaiian Islands, the Team noted that although there is definitive evidence of overfishing for opakapaka and other bottomfish species, the responsibility for management in this region is shared with the State of Hawaii. Thus, the management of the resource must be jointly proposed and enacted.

VIII. RECOMMENDATIONS FOR COUNCIL ACTION

The Team recommends that HDAR sets up an incentive program for bottomfish fishermen to promptly and accurately provide fishing information. Additionally, the Team recommends that the C-3 form be revised such that a days fished column be included.

It is also recommended that the Council should present a recommendation for joint management efforts with the state, immediately.

ESTIMATED IMPACTS OF RECOMMENDED ACTION

If an incentive program is established, cooperation from fishermen should improve as will the reliability of the HDAR database. Once days fished is added to the C-3 form, a real estimate of fishing effort and CPUE will be attainable. The biases associated with trip length will be eliminated and an assessment of the differences in fishing trips between the MHI and the NWHI will be possible. Both recommendations should result in more accurate data collection which will fulfill one of the objectives outlined in the FMP.



LEHI BEING PULLED ONTO THE KAHALA.

TERRITORY OF AMERICAN SAMOA

The following information was compiled from the American Samoa Office of Marine and Wildlife Resources' (OMWR) annual fiscal reports and its commercial landing data bases. Some mixing of calendar year and fiscal year information was necessary to produce this report in a timely manner. The data collection and processing systems that generated the information have been developing since the early 1980's and very significant modifications were implemented in October 1985. It is currently unknown to what degree the difference between FY86 and FY87 data and previous years reflect real differences in the fishery and what portion is a result of the sampling changes. Further study and analyses are needed to clarify this area. Therefore, interpretation of this summary information should be made with caution.

Bottomfishing in American Samoa is an important fishery. From 1982 to 1986, bottomfish species comprised an average of about one-third of the total landings. Most of the catch is consumed locally; however, some of the high-priced deep-water species are being shipped to the Hawaii fresh-fish market.

I. FISHERIES PERFORMANCE DATA

1. Total Landings by Area by Month

These data are available for 1982-1984 (Figure 9 and 10). The bottomfish management unit species (BMUS) monthly landings represent an average over these years. Bottomfish landings increase during the months of May through August, and are lower during the months November through February. Information regarding total landings by area are not available at present.

Figure 11 indicates that total bottomfish landings in American Samoa were highest in 1983 and have declined only slightly since that time. Figure 12 illustrates annual trends in bottomfishing from 1982 - 1984; little change is noted in the amount of bottomfish landed.

2. Ex-Vessel Revenue by Species

This information is not available at present, but the data from American Samoa will be analyzed in the future so that this topic can be specifically addressed.

3. Fishing Effort Information

A. Number of vessels, number of trips, days fished and landings per trip

FIGURE 9. AVERAGE MONTHLY BOTTOMFISH LANDINGS IN AMERICAN SAMOA BETWEEN 1982 AND 1984 (BOTTOMFISH MANAGEMENT UNIT SPECIES ARE DESIGNATED AS BMUS).

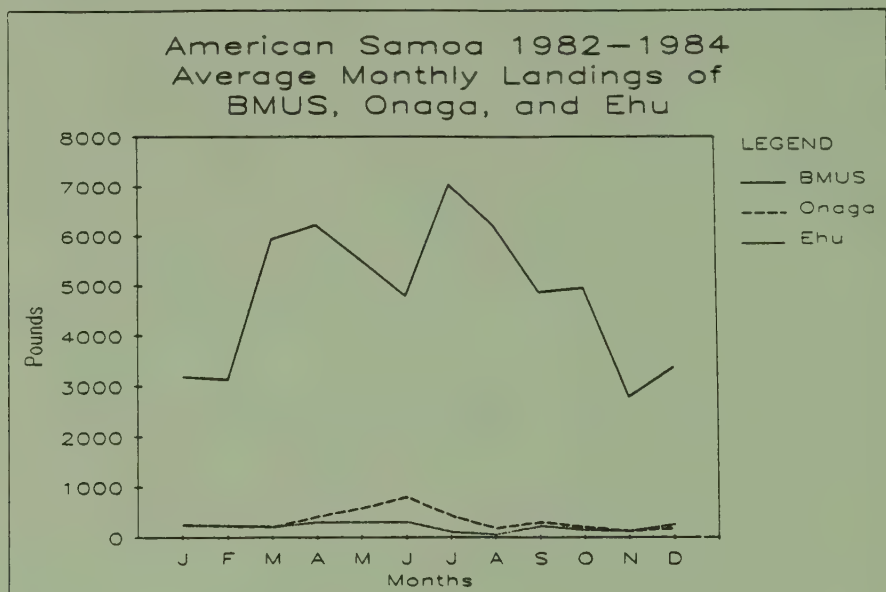


FIGURE 10. AVERAGE MONTHLY LANDINGS IN AMERICAN SAMOA BETWEEN 1982 AND 1984.

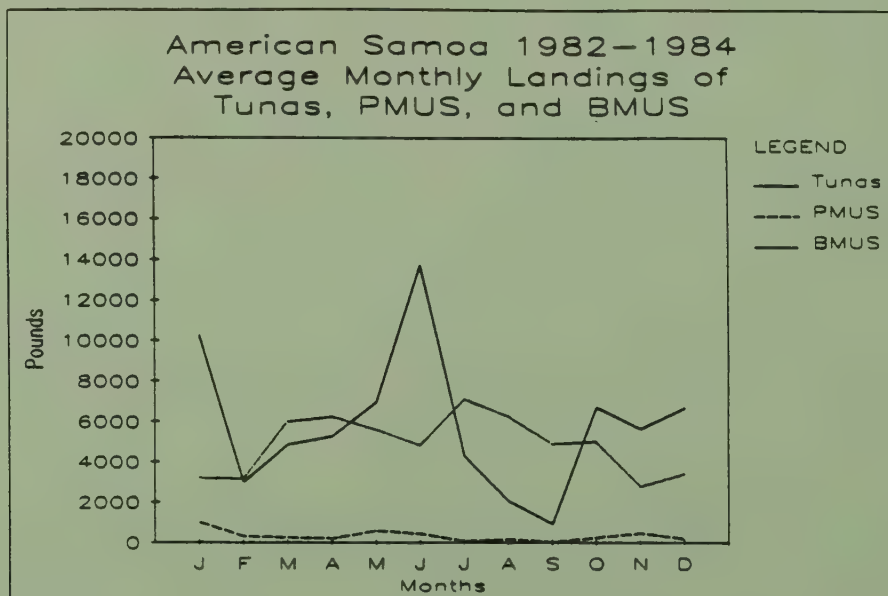


FIGURE 11. TOTAL BOTTOMFISH LANDINGS IN AMERICAN SAMOA BETWEEN 1982 AND 1985.

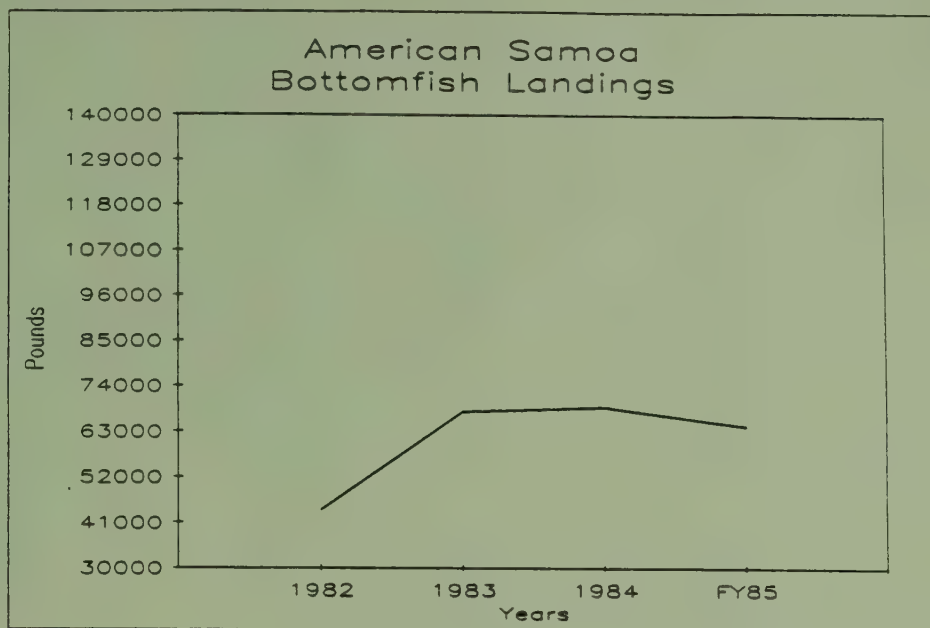
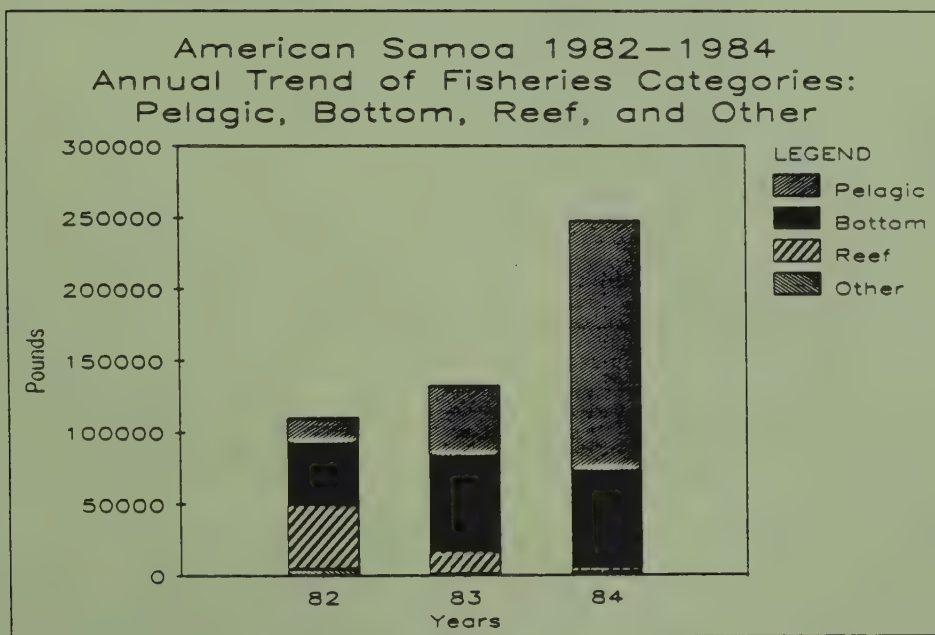


FIGURE 12. ANNUAL TRENDS IN FISHERIES TYPES IN AMERICAN SAMOA BETWEEN 1982 AND 1984.



Data exists for the number of vessels in the commercial fleet (Figure 13), but no information on the number of recreational vessels is available. The commercial fishing fleet steadily increased from 1980 to 1985, then declined in 1986 and again in 1987. A portion of the 1987 decline is a direct result of the January hurricane that destroyed the Manua Islands' fishing fleet. It is thought that the remainder of the decline is a result of decreased catch rates, and that crew shares could no longer keep some crews from leaving the fishery for more lucrative employment elsewhere.

Data concerning the actual number of fishing trips is not reported presently, but information concerning the total number of landings is available for 1982-1984 (Tables 9, 10 and 11). In 1982, 1760 landings (records in Tables 9, 10 and 11) were reported and this value rose to 2205 in 1983 and rose again to 2511 in 1984. No information is available past 1984.

The number of fishing-days are not reported in American Samoa, although some information regarding overall fishing efficiency is available. Average trip lengths were 13.7 hours and 14.5 hours in FY82 and FY83, respectively, compared to 16.2 hours in FY86, so fishermen are seemingly fishing longer to obtain acceptable catches. Caution is advised in interpretation of this trend as within-year variability overrides variability between years.

Information concerning catch rates per trip is given in Figure 14. Catch rate per trip was highest in 1983 and has steadily declined since that maximum.

B. Species composition, areas fished, catch per day by area and other indicators of fishery performance.

Data concerning the species composition of bottomfish landings are given in Table 12. There appears to be no obvious trend in the species composition of bottomfish landings between 1982 and 1984. At present, a vast majority of the reported bottomfish catch is lumped into the 'general bottomfish' category. This situation should be more closely examined before generalizations can be accurately made concerning changes in the species composition of bottomfish landings in American Samoa.

Spatial variability within the bottomfish fishery in American Samoa is currently not addressed, but this information will be more carefully assessed in future annual reports.

Statistics regarding the catch per day by area are not available for American Samoa at present. Figure 11 shows a somewhat stable total bottomfish catch up to FY85. However, when one considers that the fleet was rapidly increasing to a maximum in FY85, the slight downward

FIGURE 13. TOTAL NUMBER OF COMMERCIAL FISHING VESSELS IN AMERICAN SAMOA BETWEEN 1980 AND 1987.

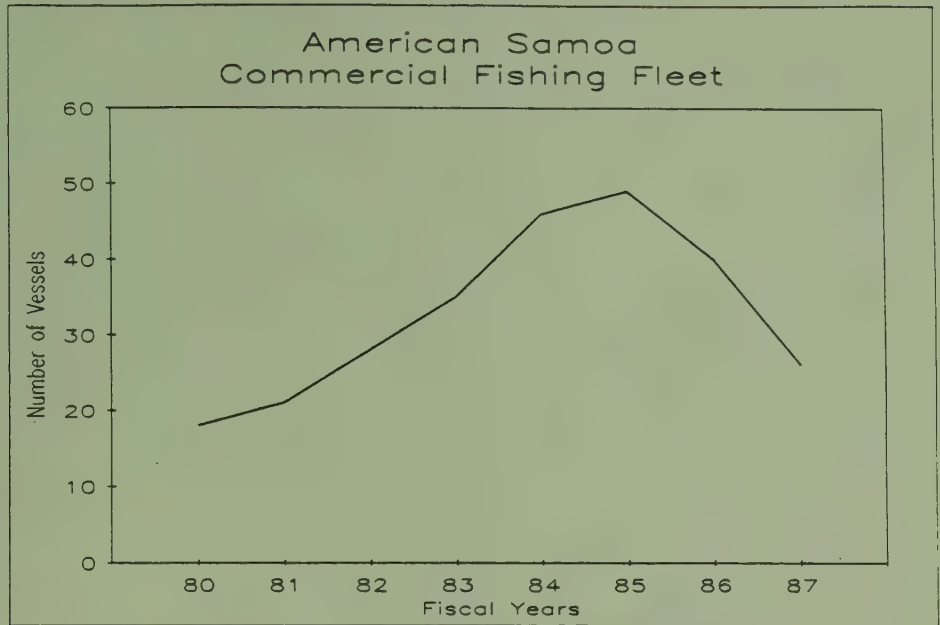


FIGURE 14. BOTTOMFISH CATCH RATES IN AMERICAN SAMOA BETWEEN 1982 AND 1986.

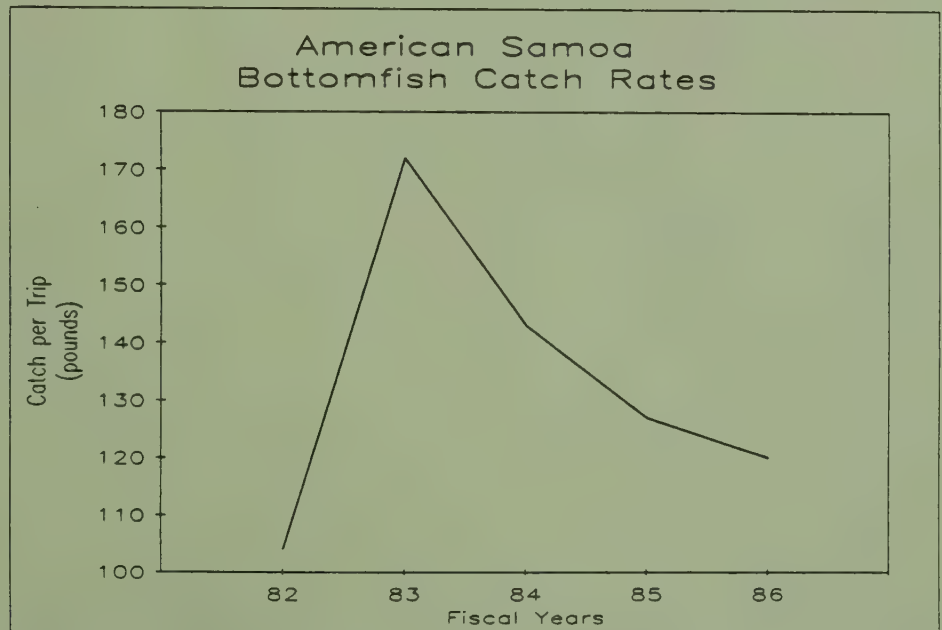


TABLE 9. AMERICAN SAMOA 1982 COMMERCIAL LANDINGS OF BOTTOMFISH SPECIES.

SPECIES	RECORDS	POUNDS	VALUE	AVE\$/#
JACKS	14	99.00	173.23	1.75
BLACK JACK	1	14.00	24.50	1.75
BOTTOMFISH	420	35709.37	62389.39	1.75
GROUPERS	16	100.25	175.41	1.75
FLAGTAIL GROUPER	2	7.00	12.25	1.75
GIANT GROUPER	1	200.00	200.00	1.00
LUNARTAIL GROUPER	24	357.75	626.05	1.75
BLUE LINED SNAPPER	49	858.30	1501.46	1.75
ONESPOT SNAPPER	2	5.00	6.26	1.25
HUMPBACK SNAPPER	34	398.00	696.45	1.75
GRAY JOBFISH	11	163.00	307.74	1.89
DEEPWATER BOTTOMFISH	11	1668.00	4953.96	2.97
YELLOW OPAKAPAKA	3	28.00	41.75	1.49
HAWAIIAN OPAKAPAKA	1	48.00	84.00	1.75
OPAKAPAKA	13	288.00	576.29	2.00
BLUE LINED GINDAI	1	9.00	15.75	1.75
GINDAI (FLOWER SNAP)	5	58.50	98.74	1.69
LEHI (SILVERJAW)	7	153.75	263.10	1.71
ONAGA (RED SNAPPER)	24	711.00	2694.78	3.79
EHU (RED SNAPPER)	23	955.00	2024.15	2.12
EMPERORS (MISC)	66	2065.39	3613.89	1.75
LONGNOSE EMPEROR	3	107.00	187.25	1.75
BLUELINE BREAM	1	15.00	26.25	1.75
SNAKE MACKEREL	1	12.00	21.00	1.75
** Total Bottomfish**	733	44030.31	80713.65	1.83
** 1982 TOTAL ALL SPECIES**				
	1760	110724.16	182087.12	1.64

TABLE 10. AMERICAN SAMOA 1983 COMMERCIAL LANDINGS OF BOTTOMFISH SPECIES.

SPECIES	RECORDS	POUNDS	VALUE	AVE\$/#
JACKS	57	1059.75	1805.76	1.70
BLACK JACK	8	81.50	104.23	1.28
BLUEFIN TREVALLY	1	3.00	3.00	1.00
AMBERJACK	1	60.00	105.00	1.75
BOTTOMFISH	294	41772.75	73060.01	1.75
GROUPERS	66	921.00	1608.43	1.75
FLAGTAIL GROUPER	1	2.00	3.50	1.75
TOMATO GROUPER	4	90.00	136.50	1.52
BLACKTIP GROUPER	1	3.00	5.25	1.75
STRIPED GROUPER	1	12.00	28.20	2.35
GIANT GROUPER	3	188.00	193.85	1.03
LUNARTAIL GROUPER	9	107.00	187.25	1.75
SNAPPERS	2	28.00	35.00	1.25
BLUE LINED SNAPPER	63	1605.25	2630.65	1.64
BLACKTAIL SNAPPER	3	60.00	84.88	1.41
ONESPOT SNAPPER	17	184.75	293.54	1.59
TWINSPO/RED SNAPPER	10	139.25	201.18	1.44
HUMPBACK SNAPPER	35	634.25	1109.17	1.75
BROWN JOBFISH	2	28.00	49.00	1.75
GRAY JOBFISH	125	3209.00	7882.58	2.46
YELLOW OPAKAPAKA	108	873.50	3550.06	4.06
HAWAIIAN OPAKAPAKA	6	93.50	244.92	2.62
GINDAI (FLOWER SNAP)	66	495.50	1089.80	2.20
YELLOWTAIL SNAPPER	6	6.50	7.10	1.09
LEHI (SILVERJAW)	111	2436.00	5532.64	2.27
ONAGA (RED SNAPPER)	272	7419.00	32536.44	4.39
EHU (RED SNAPPER)	161	3136.00	7803.54	2.49
STONE'S SNAPPER	18	1101.50	1833.63	1.66
KUSAKAR'S SNAPPER	1	13.75	24.06	1.75
EMPERORS (MISC)	67	1756.75	3066.17	1.75
LONGNOSE EMPEROR	1	35.00	43.75	1.25
SNAKE MACKEREL	2	22.00	38.50	1.75
** Total Bottomfish**	1522	67577.50	145297.59	2.15
TOTAL ALL SPECIES	2205	132791.45	210096.19	1.58

TABLE 11. AMERICAN SAMOA 1984 COMMERCIAL LANDINGS OF BOTTOMFISH SPECIES.

SPECIES	RECORDS	POUNDS	VALUE	AVE\$/#
JACKS	86	1412.25	2346.87	1.66
BLACK JACK	1	11.00	17.82	1.62
TREVALLY	1	10.00	17.50	1.75
BOTTOMFISH	291	45187.00	72095.26	1.60
GROUPERS	79	1118.00	1938.00	1.73
BLACKTIP GROUPER	2	7.25	12.68	1.75
GIANT GROUPER	2	180.00	223.80	1.24
LUNARTAIL GROUPER	44	417.60	729.75	1.75
SNAPPERS	3	95.00	148.20	1.56
BLUE LINED SNAPPER	119	2746.00	4433.12	1.61
RUFOUS SNAPPER	2	90.00	140.40	1.56
BLACKTAIL SNAPPER	10	404.00	589.50	1.46
ONESPOT SNAPPER	21	281.50	436.17	1.55
TWINSPO/RED SNAPPER	21	432.25	754.04	1.74
HUMPBAC SNAPPER	88	1257.00	2184.44	1.74
GRAY JOBFISH	78	1125.50	1843.96	1.64
DEEPWATER BOTTOMFISH	6	121.50	273.52	2.25
YELLOW OPAKAPAKA	46	883.00	2100.61	2.38
HAWAIIAN OPAKAPAKA	52	772.00	2627.48	3.40
OPAKAPAKA	2	29.25	51.18	1.75
GINDAI (FLOWER SNAP)	86	1279.25	2162.85	1.69
YELLOWTAIL SNAPPER	1	2.50	1.25	0.50
LEHI (SILVERJAW)	57	908.50	2392.10	2.63
ONAGA (RED SNAPPER)	155	3168.50	12599.77	3.98
EHU (RED SNAPPER)	139	3174.50	7223.48	2.28
BLACK SNAPPER	4	29.25	51.18	1.75
STONE'S SNAPPER	20	616.75	1076.31	1.75
KUSAKAR'S SNAPPER	1	80.00	140.00	1.75
BIGEYE EMPEROR	1	5.00	8.75	1.75
EMPERORS (MISC)	108	2767.50	4780.68	1.73
LONGNOSE EMPEROR	3	82.50	103.13	1.25
SNAKE MACKEREL	1	6.00	10.50	1.75
** Total Bottomfish**	1478	68700.35	123514.30	1.80
TOTAL ALL SPECIES	2511	247709.10	244506.03	.99

TABLE 12. SPECIES COMPOSITION OF LANDINGS (NUMBER OF RECORDS)
RECORDED FROM AMERICAN SAMOA.

SPECIES	YEAR		
	82	83	84
Jacks	14	57	86
Bottomfish	420	294	291
Groupers	16	66	79
Deepwater Bottomfish	11	-	6
Yellow Opakapaka	3	108	46
Hawaiian Opakapaka	1	6	52
Opakapaka	13	-	2
Blue-lined Gindai	1	-	-
Gindai	5	66	86
Lehi	7	111	57
Onaga	24	272	155

trend beginning in FY84 may be more significant than it appears on the graph. Once FY86 and FY87 figures can be adjusted for the differences in sampling programs implemented at the beginning of FY86, it is believed by the OMWR staff that the downward trend will continue. Further analyses are needed.

4. Biological Characteristics of the Landings

Such information is not presented in this report, but the data are currently being collected by the OMWR staff through a market-sampling program recently implemented and should be available for upcoming FMP annual reports.

5. Summary Table of Fishery Status

Status of the American Samoa Bottomfish Fishery

Problem Condition	Present in Bottomfishery	Comment
1. Age at entry is prereproduction	Data Unavailable	
2. Unacceptable ratio of fish-mortality to natural mortality	Data Unavailable	
3. Catch exceeds maximum sustainable yield	Data Unavailable	
4. Significant decline in CPUE	Potentially	Further analyses are needed.
5. Substantial decline in ex-vessel revenue relative to baseline levels	Data Unavailable	
6. Significant shift in gear, by area	Data Unavailable	
7. Significant change in the frozen/fresh components of catch	Data Unavailable	
8. Unstable pattern of entry/exit to the fishery	Yes	
9. Per trip costs exceed per trip revenues	Data Unavailable	

Problem Condition	Present in Bottomfishery	Comment
10. Significant decline or increase in total bottom-fish landings	Data Unavailable	
11. Change in species composition of catch	No	Further analyses are needed.
12. Research results indicate problems	Data Unavailable	
13. Habitat degradation or environmental problems	Data Unavailable	
14. Increased interaction with protected species	Data Unavailable	

II. RECENT RESEARCH AND SURVEY RESULTS

A cooperative program of stock-assessment between the Honolulu Laboratory and the OMWR has been implemented. The thrust of this program has been to establish a system for obtaining length-frequency data on exploited Samoan stocks. Otoliths are being collected by the personnel of the OMWR and sent to the Honolulu Laboratory for analysis. Ultimately it is the goal of this program to establish in-house assessment capability at OMWR within a 3-5 year time frame.

III. HABITAT CONDITION AND RECENT ALTERATIONS

No such information is presently available from the OMWR.

IV. ENFORCEMENT ACTIVITIES AND PROBLEMS

No information concerning this aspect of the fishery is available at this time.

V. ADMINISTRATIVE ACTIONS AND RECOMMENDATIONS

As previously mentioned, the OMWR recently began a market-sampling program to collect length and weight data for important bottomfish species harvested in American Samoa.

The OMWR indicates that several factors concerning the status of their fishery warrant examination.

It is recommended that the market-sampling program be continued so that analysis and presentation of this data can be included in future FMP annual reports.

It is recommended that the OMWR continue to improve its sampling programs to include better species identification of bottomfish landings.

It is also recommended that OMWR expedite its plans to place one of its staff on the Bottomfish Plan Monitoring Team to ensure improved analysis, interpretation, and communication of American Samoa's bottomfish fishery.

Although the analyses and summaries included in this report are preliminary, they do seem to indicate a potentially serious problem developing in the American Samoa bottomfish fishery. This general feeling of pending possible collapse of the fishery has been substantiated through personal communication with the OMWR staff who, in turn have received similar apprehensions from the fishermen themselves. It is recommended that further study and analyses of this fishery be undertaken as soon as possible to develop reliable indices of the health of the stocks and the viability of the fishery.

VI. TERRITORY MANAGEMENT ACTIONS

The OMWR has redesigned their fisheries form (to be used in 1988) such that it includes a list of bottomfish species to be used as a reference by fishermen. This should result in better species identification and recording.

VII. ASSESSMENT FOR NEED FOR COUNCIL ACTION

Assessment for need for council action is summed up below in the recommendations for council action.

VIII. RECOMMENDATIONS FOR COUNCIL ACTION

It is recommended that the Bottomfish Plan Monitoring Team help expedite the inclusion of an OMWR staff-member on the monitoring team.

It is recommended that cooperation between the Honolulu Lab and OMWR be maintained. This should be particularly true for data collection and analysis.

IX. ESTIMATED IMPACTS OF RECOMMENDED ACTION

By placing a staff-member of the OMWR on the Bottomfish Plan Monitoring Team, there will be an increased amount of communication between these two entities. Such increased communication will allow American Samoa to better assess its bottomfish fishery through methods utilized in other Western Pacific bottomfish fisheries.

Timely analysis of the bottomfish fishery data from American Samoa will help to better understand the current status of this fishery.



CAPTAIN JOHN EADS, FORMER VICE-CHAIRMAN OF THE ADVISORY PANEL
HOLDING UP ULUA CATCH ON THE F/V MOM.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

This information was compiled from the commercial landings data base of the Commonwealth of the Northern Mariana Islands (CNMI), Division of Fish and Wildlife (DFW). For a complete presentation of the CNMI data base, see Hamm and Kassman, 1986, and Hamm et al., 1986b. The Division collects "trip ticket" receipts from all major fish purchasers on Saipan; commercial sales data are not collected from Tinian or Rota. The data collection system was significantly improved during 1982. Data collected prior to 1983 are generally not comparable to those data collected from 1983 to the present. The number of hours fished per trip is not available; therefore, the catch per unit effort (CPUE) for all analyses is based on the number of trips taken. Because jack species are frequently caught in the pelagic and reefish fisheries, they were not included in summaries used to prepare the figures in this report.

Bottomfishing is not a large fishery in the CNMI (Figures 15 and 16); pelagic and reefish are the dominant fisheries in this region. The landings of bottomfish management unit species (BMUS) is less than the landings of the pelagic management unit species (PMUS). Tunas are the most important species in the commercial fisheries. Because of the relatively undeveloped status of the deepsea bottomfish fishery in the Northern Mariana Islands, no management system is proposed for this area.

I. FISHERIES PERFORMANCE DATA

1. Total Landings by Area by Month

Figure 17 illustrates the monthly catches of bottomfish for 1979-1986; peak catches occur in June and July and the lowest catches are reported in December and January. Data are available for 1979-86 in yearly increments (Tables 13) for the CNMI. This information is illustrated in Figure 16 and shows a slow, stable increase in landings over this period of time.

Total commercial landings increased from 1980 to 1984, dropped considerably in 1985, then rose to near-1984 levels in 1986 (Figure 18). Commercial bottomfish landings, however, increased to a maximum in 1985 and then decreased in 1986 (Figure 19). Figure 20 shows that the number of individual landings of bottomfish species reached a maximum in 1984 and decreased since then; this correlates directly with the plot of the number of fishing trips taken that resulted in landings of bottomfish species.

The irregular nature of the catch rate for bottomfish in the CNMI is further illustrated for two species in Figures 15 & 16. These figures indicate that there is significant variation in the catch both within and between years.

FIGURE 15. TOTAL POUNDS CAUGHT IN VARIOUS FISHING CATEGORIES IN THE CNMI BETWEEN 1979 AND 1986.

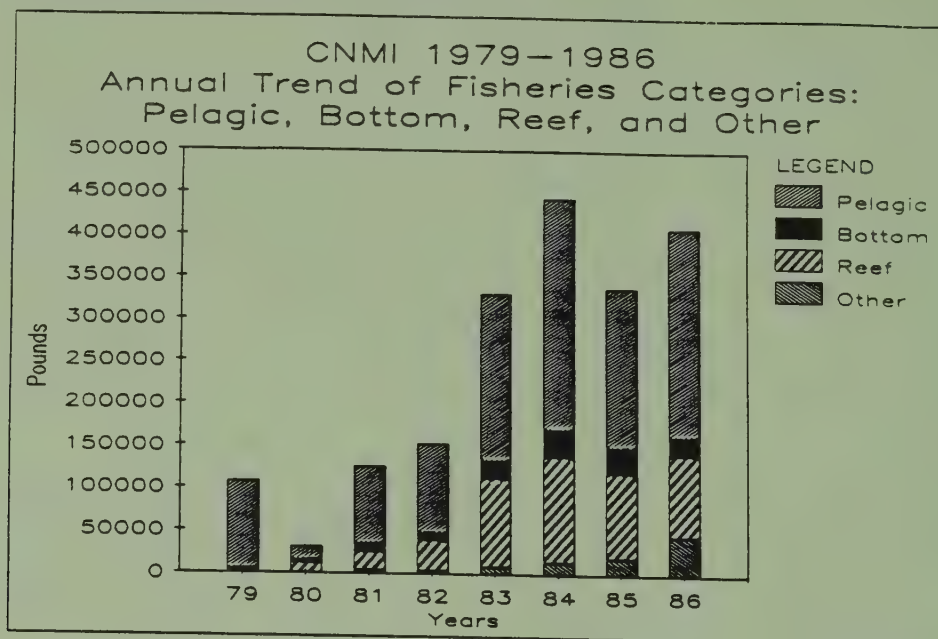


FIGURE 16. ANNUAL TRENDS OF FISHERY LANDINGS IN THE CNMI BETWEEN 1979 AND 1986.

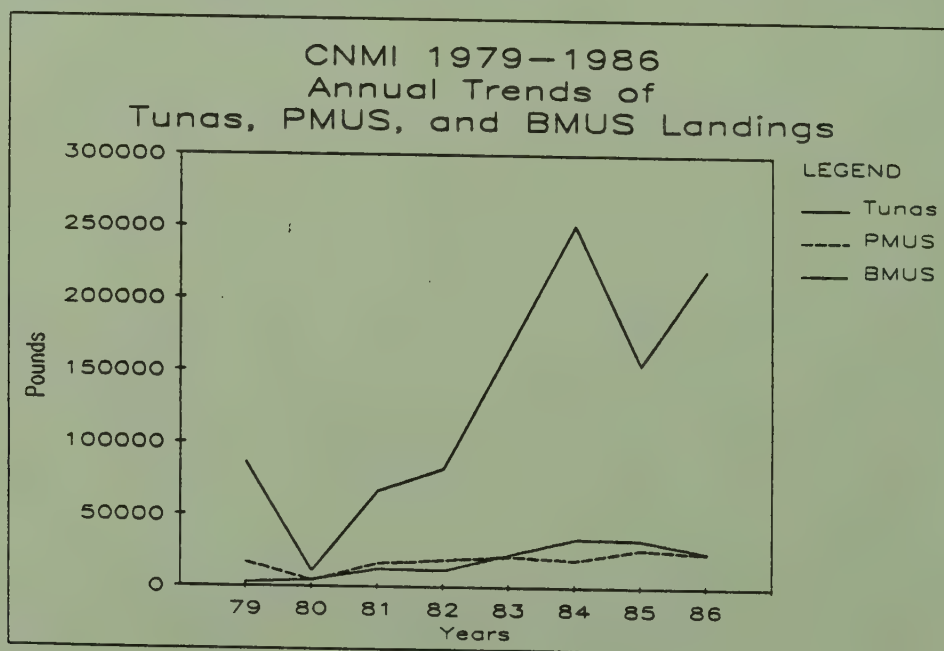


FIGURE 17. AVERAGE MONTHLY LANDINGS OF BOTTOMFISH IN THE CNMI BETWEEN 1979 AND 1986.

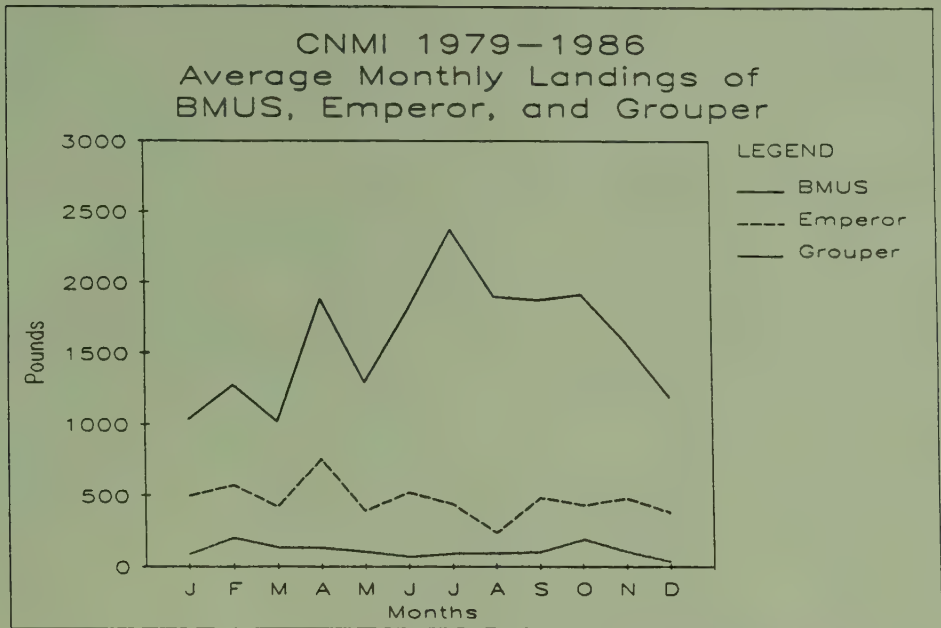


FIGURE 18. TOTAL COMMERCIAL LANDINGS IN THE CNMI BETWEEN 1979 AND 1986.

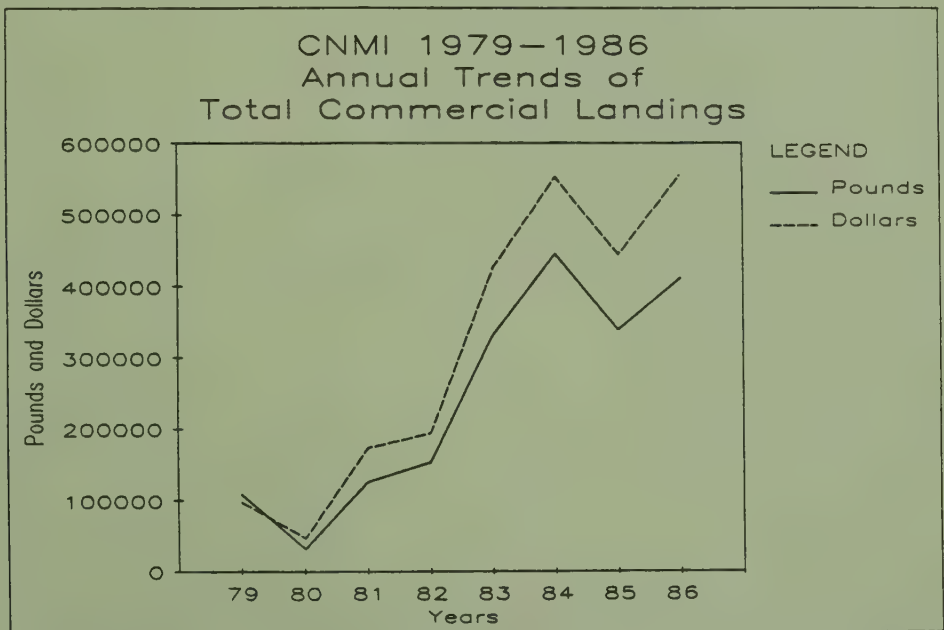


TABLE 13. ANNUAL COMMERCIAL BOTTOMFISH LANDINGS IN THE CNMI
BETWEEN 1979 AND 1985.

SPECIES	RECORDS	POUNDS	VALUE	AVE\$/#
1979				
Total Bottomfish	40	2501.90	\$ 4459.66	1.78
Total All Species	812	107712.76	\$ 96376.98	0.89
1980				
Total Bottomfish	73	3828.10	\$ 10992.75	2.87
Total All Species	279	31600.35	\$ 46591.06	1.47
1981				
Jacks	12	743.50	\$ 1356.35	1.82
Bottomfish	56	4852.50	\$ 10492.30	2.16
Gindai	1	38.00	\$ 114.00	3.00
Grouper	8	1113.00	\$ 1829.10	1.85
Lehi	1	18.00	\$ 54.00	3.00
Onaga	18	1742.50	\$ 5181.95	3.00
Total Bottomfish	96	8507.50	\$ 19432.70	2.28
Total All Species	565	125812.45	\$174491.26	1.39
1982				
Jacks	14	573.50	\$ 995.85	1.74
Bottomfish	26	7256.50	\$ 11242.63	1.55
Gindai	1	10.50	\$ 16.27	1.55
Grouper	20	569.00	\$ 977.35	1.72
Onaga	6	198.50	\$ 526.84	2.65
Opakapaka	2	86.00	\$ 215.00	2.50
Total Bottomfish	69	8694.00	\$ 13973.94	1.61
Total All Species	1058	150762.74	\$191418.21	1.27
1983				
Jacks	34	825.15	\$ 1322.47	1.60
Bottomfish	199	10398.10	\$ 18178.89	1.75
Gindai	11	213.50	\$ 432.35	2.03
Grouper	59	1090.50	\$ 1713.03	1.57
Onaga	23	894.00	\$ 2527.64	2.83
Opakapaka	38	1617.90	\$ 2917.41	1.80
Total Bottomfish	364	15039.15	\$ 27091.79	1.80
Total All Species	4909	330752.47	\$423832.71	1.28

TABLE 13 (CONTINUED).

SPECIES	RECORDS	POUNDS	VALUE	AVE\$/#
1984				
Jacks	18	724.50	\$ 1194.23	1.65
Bottomfish	272	16777.00	\$ 29665.84	1.77
Gindai	19	638.50	\$ 1255.77	1.97
Grouper	47	2512.90	\$ 3300.30	1.31
Onaga	26	820.80	\$ 2075.36	2.53
Opakapaka	22	1311.00	\$ 2560.00	1.95
Total Bottomfish	404	22784.70	\$ 40051.50	1.76
Total All Species	4976	444558.57	\$551200.93	1.24
1985				
Jacks	12	769.84	\$ 1066.99	1.39
Bottomfish	180	17522.84	\$ 29615.52	1.69
Gindai	3	166.25	\$ 325.63	1.96
Grouper	22	3368.00	\$ 4537.31	1.35
Onaga	23	893.75	\$ 2424.88	2.71
Opakapaka	10	544.95	\$ 1190.26	2.18
Uku	3	65.00	\$ 162.00	2.49
Amberjack	3	108.25	\$ 222.11	2.05
Total Bottomfish	256	23438.88	\$ 39544.70	1.69
Total All Species	3590	338427.73	\$443229.69	1.31

FIGURE 19. TOTAL COMMERCIAL BOTTOMFISH LANDINGS IN THE CNMI BETWEEN 1983 AND 1986.

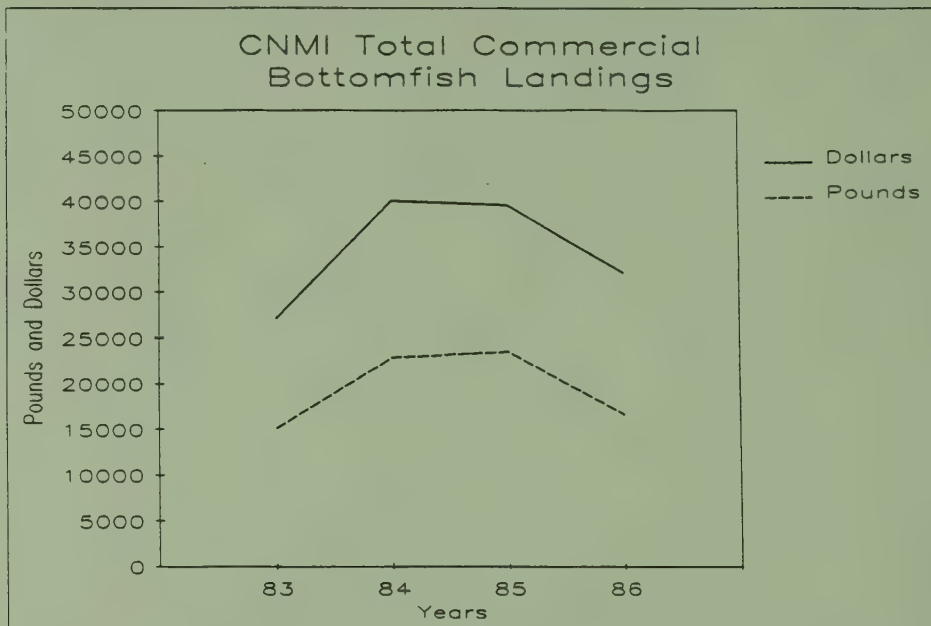
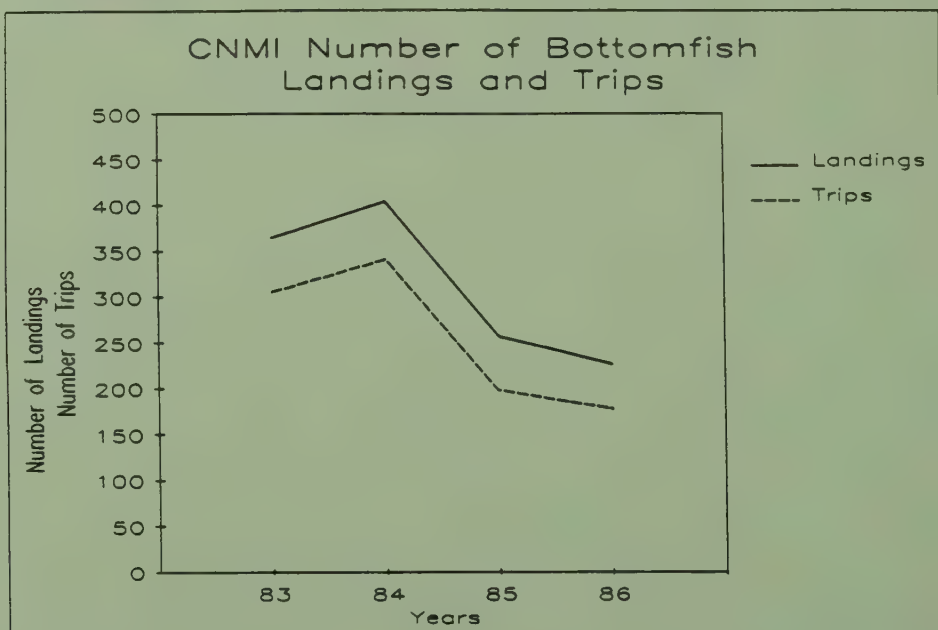


FIGURE 20. NUMBER OF BOTTOMFISH LANDINGS AND TRIPS IN THE CNMI BETWEEN 1983 AND 1986.



2. Ex-Vessel Revenues by Species

The number of vessels making landings of bottomfish species reached a maximum in 1984 and then declined to just over half the 1984 number by 1986; however, the number of vessels landing over 1,000 pounds annually remained fairly constant (Figure 21).

In the 4-year period from 1983 to 1986, 136 vessels recorded landings of bottomfish; 72 of these landed less than 100 pounds each. Only 15 vessels landed over 1,000 total pounds of bottomfish during the four-year period. Five vessels were responsible for half of the total bottomfish landings, while one of these was singly responsible for 27% of the catch. This helps explain why the total landings were not significantly affected by the drastic reduction in the number of vessels making bottomfish landings during 1985 and 1986.

3. Fishing Effort Information

A. Number of vessels, number of trips, days fished and landings per trip.

Information regarding the number of vessels in the commercial fleet is available for 1983-1986 (Figure 21). In 1983, approximately 55 vessels recorded bottomfish landings; this value rose to nearly 70 vessels in 1984 and has steadily declined since that time. The fleet was composed of approximately 45 vessels in 1985 and 38 vessels in 1986.

Information concerning the number of fishing trips is also available for 1983-1986 (Figure 20). The apparent trend in number of fishing trips appears to coincide with the number of fishing vessels in the CNMI fleet during this time period. In 1983, there were approximately 300 trips recorded; this rose to a maximum of 325 trips in 1984 and has declined since that time. Approximately 200 trips were reported in 1985 and 175 trips recorded for 1986.

Information pertaining to the number of days fished is not available at present, but should be available for the CNMI module of future annual reports.

Data concerned with the total fish caught per trip are available for the years 1983-86 (Figure 22). The apparent trend follows the same type of patterns seen for the number of fishing trips over that time period. In 1983, approximately 47 fish caught/trip were reported; in 1984, this value rose to approximately 60 fish caught/trip, and in 1985 a maximum of 110 fish caught/trip was recorded. This value fell to about 85 fish caught/trip in 1986. A portion of the maximal value obtained

FIGURE 21. NUMBER OF VESSELS MAKING COMMERCIAL BOTTOMFISH LANDINGS IN THE CNMI BETWEEN 1983 AND 1986.

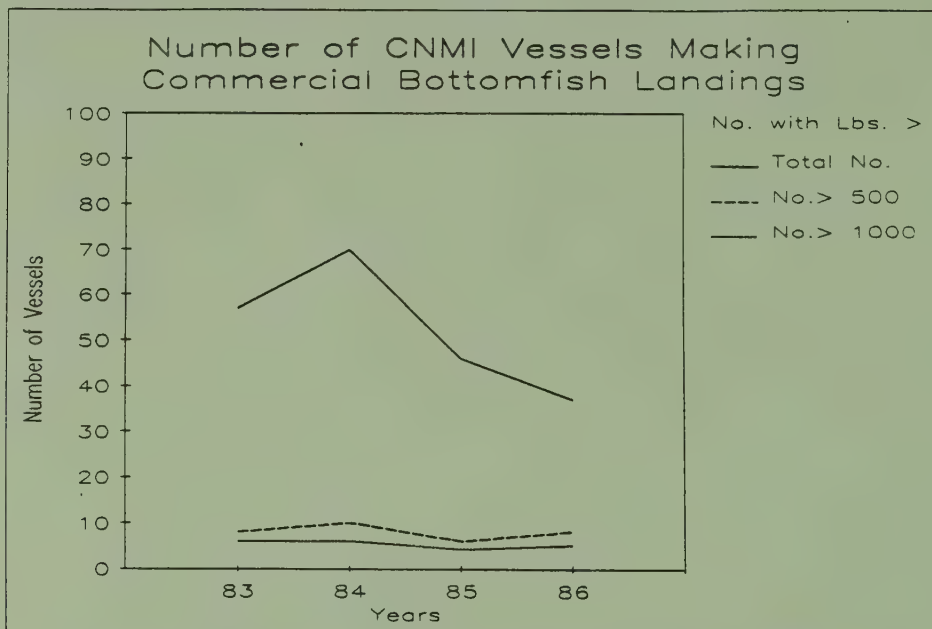
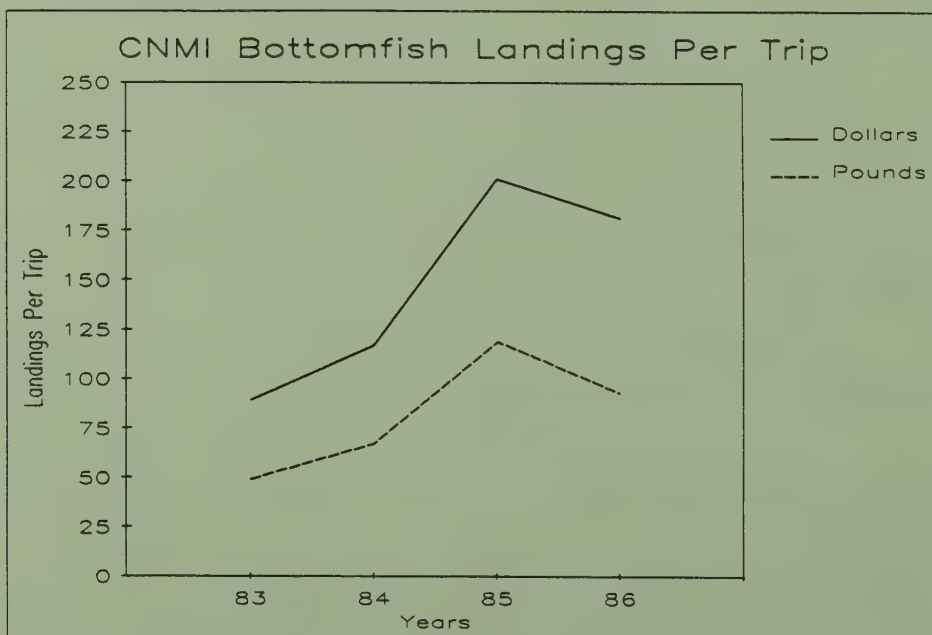


FIGURE 22. AVERAGE NUMBER OF BOTTOMFISH LANDINGS PER TRIP IN THE CNMI BETWEEN 1983 AND 1986.



in 1985 value is directly attributable to two vessels that fished more remote fishing areas (see section on areas fished).

B. Species composition, areas fished, catch per day per area and other indicators of fishery performance.

Species composition of landings is given in Table 14 for the years 1981-86. There appears to be no marked changes in the relative species composition of bottomfish landings over this time period. More thorough analyses of these data (particularly in the area of data collection) would be required before serious interpretation of this apparent pattern can be made.

Little information concerning spatial variability within the CNMI is available at present; but in 1985, two boats fishing for the Saipan Fishing Center began making extended trips. These trips were to more remote islands farther up the Mariana Archipelago. Trip length increased for these "high liners" as did their actual CPUE because they were fishing less exploited stocks. These vessels utilizing less exploited areas significantly affected the overall statistics for the CNMI bottomfish fishery of that year.

The topic of catch by area cannot be addressed presently, but an indication of temporal variability within the CNMI is indicated above.

4. Biological Characteristics of the Landings

Currently there is no good source of size frequency information for bottomfish landed in the CNMI.

TABLE 14. SPECIES COMPOSITION OF LANDINGS (NUMBER OF RECORDS)
REPORTED IN THE CNMI BETWEEN 1981 AND 1986.

<u>Species</u>	<u>Year</u>					
	81	82	83	84	85	86
Jacks	12	14	34	18	12	14
Bottomfish	56	26	199	272	180	125
Gindai	1	1	11	19	3	15
Grouper	8	20	59	47	22	23
Lehi	1	-	-	-	-	-
Onaga	18	26	23	26	23	32
Opakapaka	-	2	38	22	10	14

5. Summary Table of Fishery Status

Status of the CNMI Bottomfishery

Problem Condition	Present in Bottomfishery	Comment
1. Mean catch size is prereproduction	Data Unavailable	
2. Unacceptatable ratio of fish-mortality to natural mortality	Data Unavailable	
3. Catch exceeds maximum sustainable yield	No	Further analyses are needed.
4. Significant decline in CPUE	No	
5. Substantial decline in ex-vessel revenue relative to baseline levels	Data Unavailable	
6. Significant shift in gear, by area	Data Unavailable	
7. Significant change in the frozen/fresh components of catch	Data Unavailable	
8. Unstable pattern of entry/exit to the fishery	Yes	
9. Per trip costs exceed per trip revenues	No	

Problem Condition	Present in Bottomfishery	Comment
10. Significant decline or increase in total bottom- fish landings	No	
11. Change in species composition of catch	No	Further analyses are needed.
12. Research results indicate pro- blems	Data Unavailable	
13. Habitat degradation or environ- mental problems	Data Unavailable	
14. Increased interaction with protected species	Data Unavailable	

II. RECENT RESEARCH AND SURVEY RESULTS

No information regarding the status of recent research is given at present, but recommendations are made indicating the general direction of future research actions.

III. HABITAT CONDITIONS AND RECENT ALTERATIONS

This topic is not addressed at present, but it is felt that the fishery is being controlled currently by environmental, physical and market conditions rather than reduced resource availability.

IV. ENFORCEMENT ACTIVITIES AND PROBLEMS

No enforcement problems were reported by the DFW for inclusion in this module.

V. ADMINISTRATIVE ACTIONS AND RECOMMENDATIONS

It is recommended that the DFW begin a sampling program to provide size-frequency data to facilitate improved analysis and monitoring of the fishery.

It is recommended that the DFW upgrade its data collection system to obtain better species identification of bottomfish landings, to obtain information on area fished and hours fished, and expand coverage of the system to include Tinian and Rota.

VI. TERRITORY MANAGEMENT ACTIONS

No territorial actions are included in this module of the annual report.

VII. ASSESSMENT FOR NEED FOR COUNCIL ACTION

Assessment for need for Council action is outlined in the recommendations for Council action below.

VIII. RECOMMENDATIONS FOR COUNCIL ACTION

It is recommended that the Bottomfish Plan Monitoring Team place a representative of the CNMI DFW on the team.

It is recommended that the Monitoring Team initiate a method by which CNMI bottomfish fisheries data are analyzed in a timely fashion so that managerial needs may be anticipated.

IX. ESTIMATED IMPACTS FOR RECOMMENDED ACTIONS

By having a representative on the Monitoring Team, the DFW will be able to collect and analyze their bottomfish fisheries data in a more meaningful manner.



BOTTOMFISH CATCH OFF THE COAST OF ROTA, CNMI.

TERRITORY OF GUAM

Guam is very similar to the CNMI in that the pelagic fishery is, by far, the most important fishery. Bottomfish landings generally comprise less than 5 % of the total harvest (Figure 23 and Table 15). However, landings of the pelagic management unit species (PMUS) make up a much larger percentage of the total landings in Guam than in the CNMI (Figure 24).

The following information was compiled from the WPACFIN Guam commercial landings data base and from the Guam Division of Aquatic and Wildlife Resources (DAWR) offshore creel survey data bases. Since 1982, trip ticket invoices have been used by the major fish purchasers on Guam to record their transactions. Copies of the invoices are provided to WPACFIN for processing. Commercial landings data prior to 1983 do not contain invoice numbers nor a measure of effort and were unusable for some of the analyses. Similarly, only landings for which fishing effort was recorded were used to produce graphs of effort summaries. As in the CNMI, landings of jack species were excluded from some of the graphs because these species are frequently caught by other methods of fishing. The DAWR's creel survey programs were modified in 1983 to improve their estimates of catch and effort. Reported data from the creel surveys are for the method "bottomfishing" and include all handline and pole-and-line bottomfishing from a boat.

I. FISHERIES PERFORMANCE DATA

1. Total Landings by Area and Month

Information concerning the total landings on a monthly basis is given in Figure 25 (the raw data for these figures are found in Hamm and Kassman, 1986, and Hamm et al., 1986b). These data represent the years 1979-1984. There is a maximum bottomfish harvest during the spring and summer months (April - June) and a minimum harvest during the winter months (November - February). Information concerning landings per area is not available at present.

Table 15 provides annual summaries of the reported commercial landings for bottomfish species for 1979-86. The column labeled "RECORDS" is the number of individual landings made of each species, regardless of the size of the landing. These data are summarized in Figures 23 and 24 for bottomfish management unit species (BMUS) for the years 1979 - 1984. These indicate an overall increase in landings of bottomfish in Guam's bottomfish fishery.

FIGURE 23. TOTAL LANDINGS (POUNDS) IN VARIOUS FISHING CATEGORIES IN GUAM BETWEEN 1979 AND 1984.

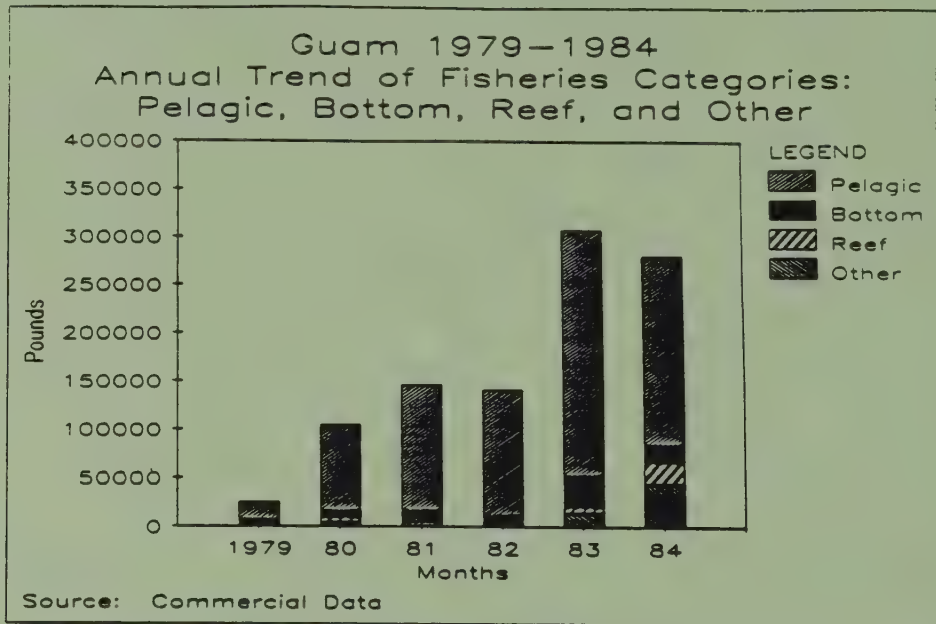


FIGURE 24. COMMERCIAL LANDINGS (POUNDS) ON GUAM BETWEEN 1979 AND 1984.

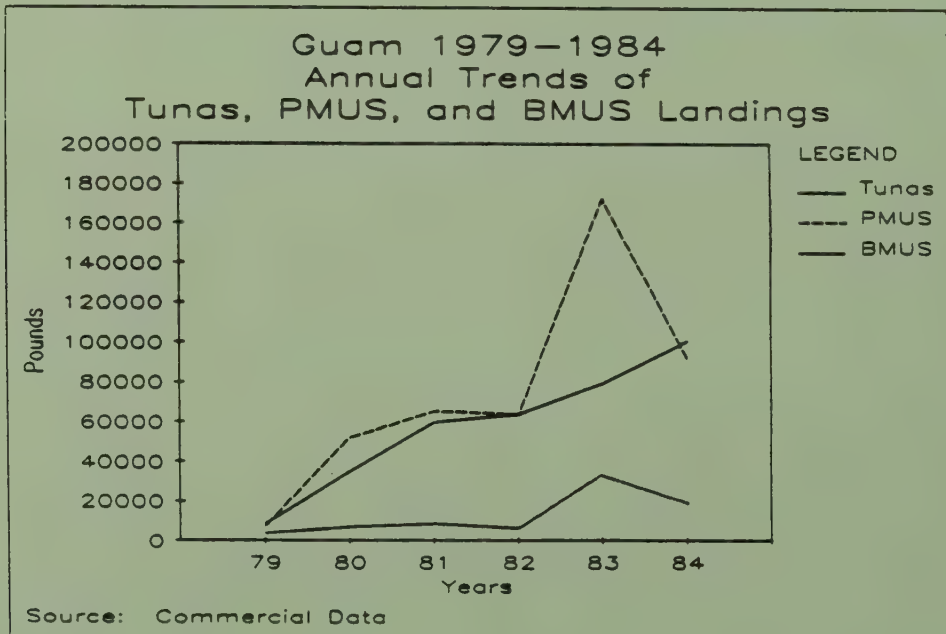


TABLE 15. BOTTOMFISH LANDINGS IN GUAM BETWEEN 1979 AND 1986

Species	Records	Pounds	Value	Ave\$/#
1979				
Bottomfish	77	3026.00	\$ 4539.31	1.50
Grouper	2	243.00	\$ 364.50	1.50
Lehi	1	13.00	\$ 19.50	1.50
Onaga	10	153.75	\$ 252.65	1.64
Total Bottomfish	90	3435.75	\$ 5175.96	1.51
Total All Species	506	25607.45	\$ 31648.04	1.23
1980				
Bottomfish	105	4073.00	\$ 5031.46	1.25
Gindai	2	775.00	\$ 775.00	1.00
Grouper	12	1450.00	\$ 1600.50	1.10
Lehi	3	112.00	\$ 148.00	1.32
Onaga	11	521.50	\$ 859.00	1.65
Opakapaka	2	62.00	\$ 62.00	1.00
Total Bottomfish	135	6975.50	\$ 8475.96	1.22
Total All Species	1878	105013.55	\$134310.37	1.28
1981				
Bottomfish	176	6506.27	\$ 11262.18	1.75
Grouper	8	768.00	\$ 1342.75	1.75
Lehi	17	487.00	\$ 974.00	2.00
Onaga	30	606.00	\$ 1193.03	1.97
Total Bottomfish	231	8367.43	\$ 14871.96	1.78
Total All Species	2649	145969.69	\$206162.26	1.41
1982				
Jacks	17	133.40	\$ 266.80	2.00
Bottomfish	95	3266.94	\$ 6261.90	1.92
Gindai	8	37.00	\$ 74.00	2.00
Grouper	35	977.25	\$ 2809.25	1.85
Lehi	17	481.75	\$ 963.50	2.00
Onaga	9	125.00	\$ 258.00	2.06
Opakapaka	11	176.29	\$ 352.58	2.00
Total Bottomfish	192	5197.63	\$ 9986.03	1.92
Total All Species	2513	140761.87	\$194941.95	1.38

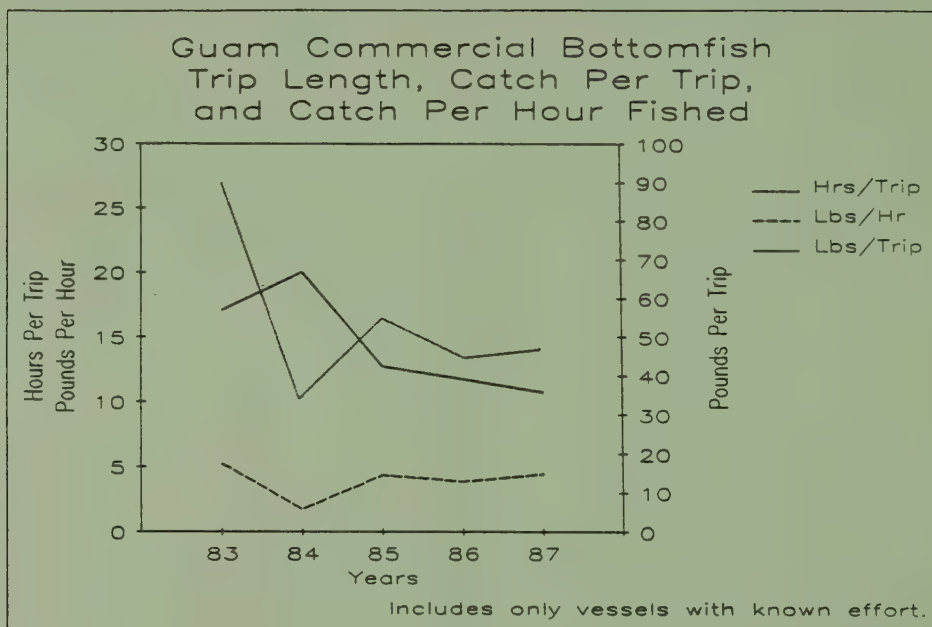
TABLE 15 (CONTINUED).

Species	Records	Pounds	Value	Ave\$/#
1983				
Jacks	68	1215.77	\$ 1677.82	1.38
Bottomfish	365	17848.70	\$ 34511.41	1.93
Ehu	7	90.23	\$ 212.29	2.35
Gindau	24	1333.83	\$ 2667.14	2.00
Grouper	35	6733.04	\$ 8869.27	1.32
Kalikali	1	42.21	\$ 84.42	2.00
Lehi	20	1619.99	\$ 2750.11	1.70
Onaga	21	1478.51	\$ 3564.55	2.41
Opakapaka	35	987.88	\$ 2300.66	2.33
Uku	4	76.81	\$ 115.21	1.50
Total Bottomfish	580	31426.97	\$ 56752.88	1.81
Total All Species	5585	311029.11	\$443923.35	1.43
1984				
Jacks	138	2581.76	\$ 4541.79	1.76
Bottomfish	159	5681.28	\$ 11051.47	1.95
Ehu	13	146.10	\$ 336.55	2.30
Gindai	25	344.10	\$ 700.09	2.03
Grouper	50	1211.74	\$ 1919.65	1.58
Kalikali	24	715.67	\$ 1415.90	1.98
Lehi	26	946.31	\$ 1905.23	2.01
Onaga	9	186.25	\$ 483.00	2.59
Opakapaka	26	761.75	\$ 1655.07	2.17
Uku	76	1697.82	\$ 3265.06	1.92
Total Bottomfish	546	14272.78	\$ 27273.81	1.91
Total All Species	5393	281402.10	\$420423.19	1.49
1985				
Jacks	130	3724.07	\$ 5249.68	1.41
Bottomfish	314	12590.08	\$ 24950.25	1.98
Ehu	9	311.50	\$ 660.07	2.12
Gindai	14	525.00	\$ 2095.70	2.09
Grouper	14	873.40	\$ 1064.45	1.22
Kalikali	8	459.00	\$ 918.00	2.00
Lehi	13	606.75	\$ 1243.50	2.05
Onaga	18	662.00	\$ 1748.00	2.64
Opakapaka	13	554.25	\$ 1134.00	2.05

TABLE 15 (CONTINUED).

Species	Records	Pounds	Value	Ave\$/#
1985 (cont.)				
Opakapaka	13	554.25	\$ 1134.00	2.05
Uku	72	1710.05	\$ 2667.15	1.56
Total Bottomfish	605	22016.10	\$ 40730.80	1.85
Total All Species	5950	296623.56	\$489249.19	1.65
1986				
Jacks	97	2668.21	\$ 3691.12	1.38
Bottomfish	139	3885.05	\$ 7544.89	1.94
Ehu	13	364.50	\$ 812.15	2.23
Gindai	18	646.75	\$ 1398.57	2.16
Grouper	8	588.40	\$ 728.46	1.24
Kalikali	9	316.00	\$ 607.13	1.92
Lehi	14	522.25	\$ 1129.56	2.16
Onaga	10	170.50	\$ 452.01	2.65
Opakapaka	15	553.10	\$ 1201.08	2.17
Uku	28	538.50	\$ 820.25	1.52
Total Bottomfish	351	10253.26	\$ 18385.22	1.79
Total All Species	4944	237512.46	\$365671.73	1.54

FIGURE 25. AVERAGE BOTTOMFISH TRIP LENGTH, CATCH PER TRIP AND CATCH PER HOUR FISHED IN GUAM BETWEEN 1983 AND 1987.



2. Estimated Ex-Vessel Revenue by Species

This information is not available on a per-species or ex-vessel basis, but the overall revenues for bottomfish landings for the years 1979-86 are given in Figure 26. Since 1979, total bottomfish revenues have varied considerably. The maximum revenues were reported in 1983 and have declined since that time.

3. Fishing Effort Information

A. Number of vessels, number of trips, days fished and landings per trip.

Data concerning the number of vessels fishing in the bottomfish fishery is available for 1983-86, but is restricted to only those vessels with a known fishing effort (Figure 27). In 1983, approximately 32 vessels reported bottomfish landings on Guam; this value reached a maximum in 1985 when the commercial fleet was composed of approximately 47 vessels. The fleet decreased to 38 vessels in 1986.

Information on the number of fishing trips is available for the period 1979-84 (Figure 28). These data indicate an increase in the number of trips up to 1981, and then an overall decline in the number of bottomfish trips taken through 1984.

The total number of fishing days is not available at present, but information regarding trip length is given in Figure 25. In 1979, the mean trip length was approximately 4.5 hrs/trip. This rose to a maximum of 5 hrs/trip in 1980 and has steadily decreased since 1980. In 1984, the average trip length was just under 4 hrs/trip.

Figure 25 shows that, except for some anomaly in 1984, there has been a general decline in the average length of a fishing trip and in the average catch per trip, but that the catch rate (pounds per hour) has remained fairly constant.

Figures 28 and 29 are graphs of the creel survey expansion data for 1979-84. These data typically include commercial landings, but during 1983, DAWR did not include landings made by the two "high liners" responsible for the majority of the commercial landings for that year. The creel survey graphs show similar trends as those for the commercial fishery. There appears to be a direct correlation between trip length and pounds caught, and the catch rate (pounds per hour) does not seem to be declining.

Table 16 provides estimates of the total catch and effort from the DAWR creel census surveys. The CPUE is a measure of

FIGURE 26. TOTAL COMMERCIAL BOTTOMFISH LANDINGS (IN POUNDS AND DOLLARS) IN GUAM BETWEEN 1979 AND 1986.

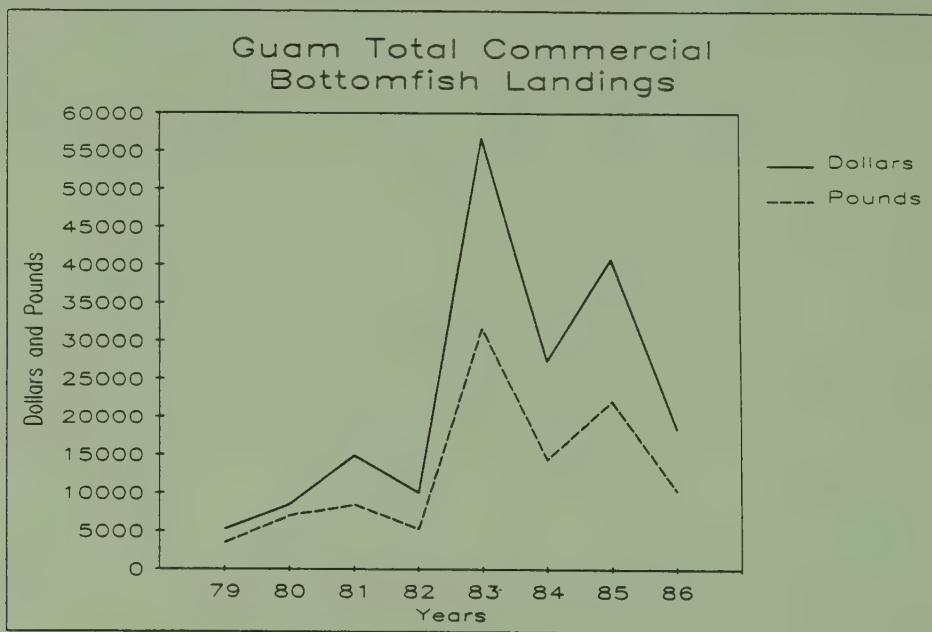


FIGURE 27. NUMBER OF FISHING VESSELS MAKING COMMERCIAL BOTTOMFISH LANDINGS IN GUAM BETWEEN 1983 AND 1986.

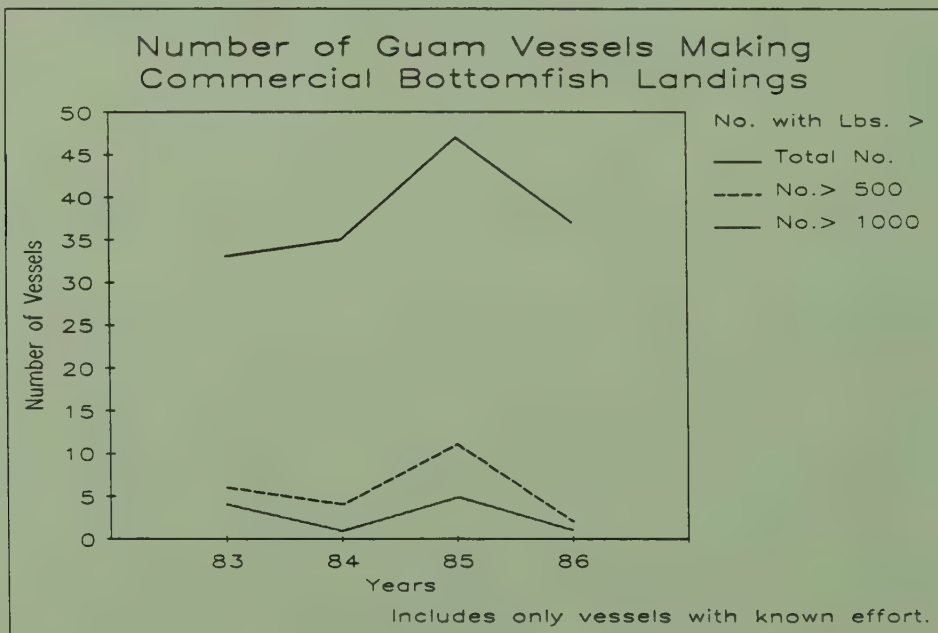


FIGURE 28. CATCH AND EFFORT ESTIMATES FOR GUAM BETWEEN 1979 AND 1984.

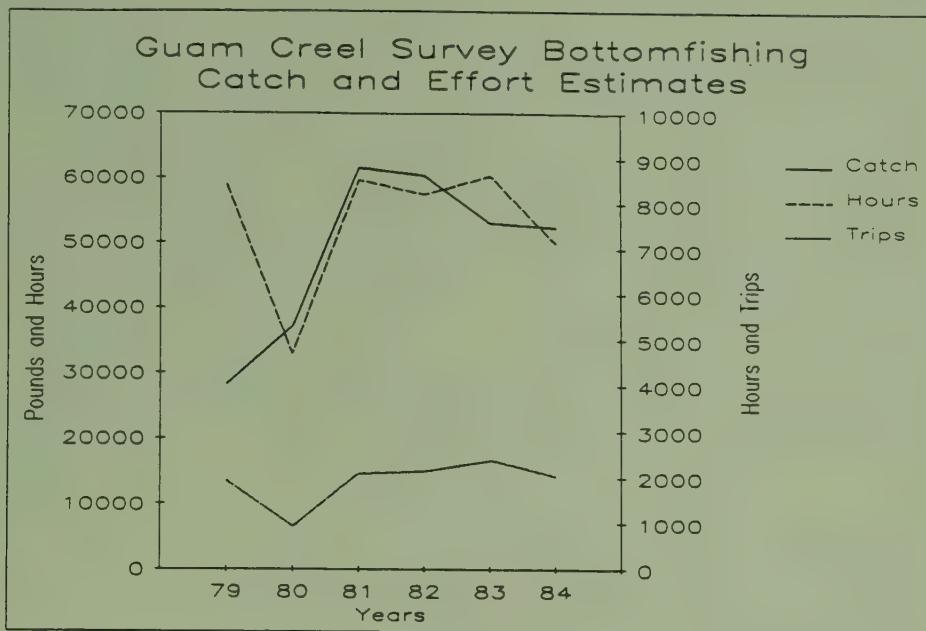


FIGURE 29. BOTTOMFISHING TRIP LENGTH, CATCH PER TRIP AND CATCH PER HOUR FOR GUAM BETWEEN 1979 AND 1984.

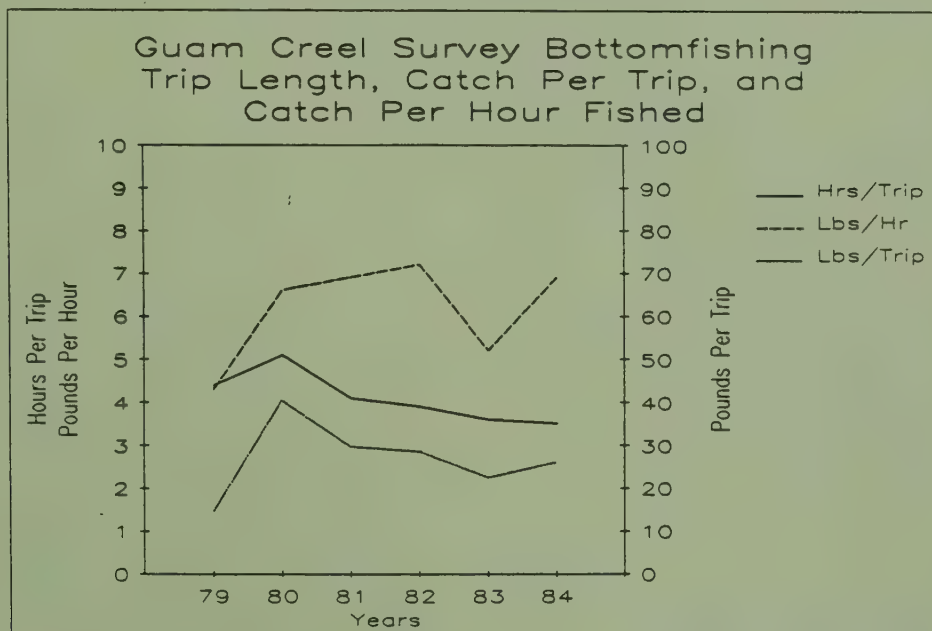


TABLE 16. GUAM DAWR 1979-1984 ANNUAL BOTTOMFISHING CREEL SURVEY SUMMARY.

Year	Catch	Boat hrs	Hours/ Boat	Man hrs	Hours/ Man	CPUE*
1979	28243.1	8415.9	1918.1	20023.6	4553.8	4.3
1980	37149.2	4703.7	918.8	10860.4	2197.0	6.6
1981	61639.0	8523.1	2081.7	22608.0	5468.0	6.9
1982	60416.7	8215.1	2129.3	18011.5	4856.6	7.2
1983	53002.3	8620.0	2378.5	18589.1	5230.3	5.2
1984	52354.6	7140.6	2018.9	19157.0	5336.8	6.9

* - CPUE is based on boat hours.

TABLE 17. SPECIES COMPOSITION OF LANDINGS (NUMBER OF RECORDS) RECORDED FROM GUAM BETWEEN 1979 AND 1986.

Species	Year							
	79	80	81	82	83	84	85	86
Jacks	-	-	-	17	68	138	130	97
Bottomfish	77	105	176	95	365	159	314	139
Ehu	-	-	-	-	7	13	9	13
Gindai	-	2	-	8	24	25	14	18
Grouper	2	12	8	35	35	50	14	8
Kalikali	-	-	-	-	1	24	8	9
Lehi	1	3	17	17	20	26	13	14
Onaga	10	11	30	9	21	9	18	10
Opakapaka	-	2	-	11	35	26	13	15
Uku	-	-	-	-	4	76	72	28

catch per boat hour and was calculated from the observation over the whole year rather than by dividing the estimated annual catch by the estimated annual boat hours.

B. Species composition, areas fished, catch per day by area, and other indicators of fishery performance.

Table 17 represents the number of records reported for bottomfish landings between 1979 and 1986. The methods of data collection have not been consistent within this period, so caution should be used if interpretation of these data are made without further evaluation of the data-collection methods. Nonetheless, it appears that there have been no major shifts in the species composition of bottomfish landings over this period.

Figure 30 shows the seasonal distribution of bottomfish landings. Most landings are made during the calmer summer months when the major pelagic fisheries for mahimahi and wahoo are least active.

Information concerning all aspects of spatial variation of bottomfish fisheries on Guam is not available at present, but should be available for future annual reports.

Although fishing efficiency by area data are unavailable, Figures 25 and 29 illustrate the overall fishing efficiency for Guam's fleet from 1983 to 1987. The catch (pounds) per trip has fluctuated during this time, with a maximum in 1983, a decrease in 1984, followed by an increase in 1985. Present catch-per-trip figures are similar to those of 1985. More specific groupings of these data should be available in future annual reports.

The Guam bottomfish fishery has fluctuated considerably since 1979, the earliest year for which data are available. Commercial landings peaked in 1983, dropped drastically in 1984, rose again in 1985, and then declined in 1986 (Figure 26). Based on landings made during the first 8 months of 1987, projected landings for 1987 will be even lower than 1986. Figure 27 shows the fluctuation in the fishing fleet making commercial bottomfish landings since 1983. Two vessels were responsible for landing 58% of the 1983 peak landings. Both vessels left the fishery by 1984; this resulted in the 55% drop in bottomfish landings for 1984. In 1985, the number of vessels reporting significant (more than 500 pounds) landings of bottomfish increased more than threefold over 1984, but in 1986, it dropped below the 1984 level. The graph of total landings (Figure 26) mirrors the vessel fluctuation.

Although there does not appear to be a biological basis for the large fluctuations in the Guam bottomfish fishery, it is recommended that further analyses be undertaken to validate this belief.

4. Biological Characteristics of the Landings

Review of DAWR creel survey size frequency data revealed that the existing sampling program does not collect a sufficient number of samples of individual length measurements for even the most frequently landed bottomfish species.

5. Summary Table of Fishery Status

Status of the Guam bottomfishery.

Problem Condition	Present in Bottomfishery	Comment
1. Mean catch size is prereproduction	Data Unavailable	
2. Unacceptable ratio of fish-mortality to natural mortality	Data Unavailable	
3. Catch exceeds maximum sustainable yield	Data Unavailable	It is felt resources are limiting the fishery.
4. Significant decline in CPUE	No	Further analyses are needed.
5. Substantial decline in ex-vessel revenue relative to baseline levels	Data Unavailable	
6. Significant shift in gear, by area	Data Unavailable	
7. Significant change in the frozen/fresh components of catch	Data Unavailable	
8. Unstable pattern of entry/exit to the fishery	Yes	
9. Per trip costs exceed per trip revenues	Data Unavailable	

Problem Condition	Present in Bottomfishery	Comment
10. Significant decline or increase in total bottom- fish landings	Yes	General increase, but sporadic.
11. Change in species composition of catch	No	Further analyses are needed.
12. Research results indicate pro- blems	Data Unavailable	
13. Habitat degradation or environ- mental problems	Data Unavailable	
14. Increased interaction with protected species	Data Unavailable	



SCHOOL OF BUTAGUCHI OFF MIDWAY ISLAND.

II. RECENT RESEARCH AND SURVEY RESULTS

See section above.

III. HABITAT CONDITIONS AND RECENT ALTERATIONS

No information regarding this topic is available at present.

IV. ENFORCEMENT ACTIVITIES AND PROBLEMS

No information regarding enforcement aspects of Guam's bottomfish fishery is available at present.

V. ADMINISTRATIVE ACTIONS AND RECOMMENDATIONS

It is recommended that the existing size-frequency sampling program be modified so that sample sizes are sufficient to properly monitor this aspect of the fishery.

It is recommended that the existing commercial landings system be expanded to include some of the smaller direct purchasers of fish (stores, hotels, restaurants), and that the system be improved to collect better effort data and better species breakdown of the catch.

It is recommended that further analyses and studies be conducted to better describe the fishery, explain and interpret the fluctuations in the fishery and make recommendations for stabilization of the fishery. Studies of stock assessment are also needed.

VI. TERRITORY MANAGEMENT ACTIONS

No information is available on territorial actions through the DAWR.

VII. ASSESSMENT FOR NEED FOR COUNCIL ACTION

Assessment for needs for Council action are summarized below in the recommendations for action.

VII. RECOMMENDATIONS FOR COUNCIL ACTION

It is recommended that a DAWR staff-person be placed on the Bottomfish Plan Monitoring Team and be made responsible for preparation of the Guam module of future annual reports.

It is recommended that further analyses be undertaken so that the status of the bottomfish fishery in Guam can be better understood.

IX. ESTIMATED IMPACTS OF RECOMMENDED ACTION

By placing a DAWR staff-person on the Bottomfish Plan Monitoring Team, and making this person responsible for the Guam module, more continuity of data reporting will be attained so that the fishery in Guam can be compared to other regions under consideration.

Further analysis of the data already available will allow the Bottomfish Plan Monitoring Team a more accurate description of the current status of the fishery on Guam.

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APPENDIX A

SUMMARY TABLES AND FIGURES OF THE
HDAR CATCH REPORT DATA FOR THE
YEARS 1985 AND 1986.

TABLE 1. KALEKALE CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES KALEKALE

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	1791	1233	84	315	453	1052	1238	878	1281	886	2323	2188	13682	
BAKER	569	328	135	269	86	72	83	298	655	309	927	1692	5423	
OAHU	196	189	89	182	84	67	73	81	67	70	56	143	1297	
KURE	1693	734	17	174	150	67	95	124	293	241	914	934	5035	
KIHOA	-	-	-	-	-	-	-	-	-	-	-	107	107	
TAU	-	-	-	62	20	72	234	131	-	-	-	-	519	
BECKER	237	102	119	-	-	6	55	-	38	-	42	109	708	
BROOKS	-	19	-	-	-	-	-	-	-	162	-	-	181	
BOGATIUM	-	-	-	-	-	-	-	-	-	-	76	-	76	
BAITA	-	-	-	-	-	-	-	97	-	-	-	-	97	
NORTHMAN	-	-	-	-	-	16	85	4	513	99	31	115	863	
OTHER	77	29	18	4	1	57	-	-	-	-	-	98	284	
SUMMARY	4563	2634	462	1006	794	1409	1863	1613	2847	1767	4360	5346	28672	

TABLE 2. OPAKAPAKA CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES OPAKAPAKA

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	7896	4149	652	1234	1568	2374	1172	1785	3222	3095	12012	7091	46250	
BAKER	19609	12722	1393	2514	853	1732	1801	4444	9351	7537	17440	17321	96725	
OAHU	4692	1135	82	327	29	449	297	634	1139	1546	785	4216	15331	
KURE	1736	3654	78	196	232	270	65	2271	1733	654	1284	4267	16440	
KIHOA	-	-	-	-	-	-	-	-	-	-	-	781	781	
TAU	-	-	-	6834	2031	1745	6971	2354	-	-	-	-	19935	
BECKER	7020	7517	1950	1000	-	410	232	-	892	389	8457	6331	34198	
PRIGATE	7110	74	-	-	-	-	-	-	85	-	-	-	7269	
BROOKS	-	3762	-	-	-	-	-	-	-	4087	-	-	7849	
BOGATIUM	-	-	-	-	-	-	-	-	-	-	2124	-	2124	
GARDNER	-	-	-	-	-	-	-	-	2102	-	-	-	2102	
BAITA	-	-	-	-	-	-	-	585	-	-	-	-	585	
BARO	-	-	-	-	-	-	-	-	2507	-	-	2278	4785	
NORTHMAN	-	-	-	-	6830	5383	9433	3849	2653	-	5270	3416	36834	
OTHER	1260	5054	12	259	38	69	60	-	150	777	3149	1442	12310	
SUMMARY	49323	38069	4167	12364	11581	12432	20031	15922	23430	18085	50527	47183	303518	

TABLE 3. UKU CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES UKU

AREA	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
HAWAII	826	211	37	278	478	606	532	966	505	384	654	908	6385	
HLKB	2960	526	60	1188	3861	6603	3514	1707	2518	1579	1661	4189	30326	
LOAHU	439	178	4	20	-	201	132	727	1262	664	113	150	3890	
KKK	1684	414	26	420	810	1583	709	610	332	229	670	1176	8663	
MIHOA	-	-	-	-	-	-	-	-	-	-	-	18	18	
TIUB	-	-	-	-	-	71	6	17	-	-	-	-	94	
NECKER	104	47	-	-	-	9	-	-	-	16	-	-	174	
PRIGATE	86	-	-	-	-	-	-	-	-	-	-	-	86	
BROOKS	-	-	-	-	-	-	-	82	-	22	-	-	104	
MOGATISB	-	-	-	-	-	-	-	-	-	-	18	-	18	
GARDNER	-	-	-	-	-	-	-	-	14	-	-	-	14	
LAITA	-	-	-	-	-	-	-	25	-	-	-	-	25	
NORTHMAN	-	-	-	-	-	35	-	-	-	-	17	11	63	
OTHER	9	-	-	54	1884	2098	813	-	-	-	-	12	4869	
SUMMARY	6107	1376	127	1920	7033	11206	5706	4134	4631	2894	3133	6464	50731	

TABLE 4. EHU CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES EHU

AREA	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
HAWAII	1824	1231	304	1278	1215	1624	1164	1154	1353	1638	3999	5301	22085	
HLKB	1703	1609	418	1700	850	1531	765	1291	1701	1249	2876	3699	19388	
LOAHU	399	222	83	54	189	183	87	159	114	118	324	249	2140	
KKK	1795	1407	201	836	353	445	193	1234	1309	959	1193	2501	12426	
MIHOA	-	-	-	-	-	-	-	-	-	-	-	175	175	
TIUB	-	-	-	695	502	856	138	488	-	-	-	-	2679	
NECKER	441	352	238	-	-	362	29	-	91	844	499	205	3101	
BROOKS	-	-	-	500	-	-	-	-	-	949	-	-	1449	
MOGATISB	-	-	-	-	-	-	-	-	-	-	963	-	963	
GARDNER	-	-	-	-	-	-	-	-	22	-	-	-	22	
LAITA	-	-	-	-	-	-	-	20	-	-	-	-	20	
BARU	-	-	-	-	-	-	-	-	709	-	-	12	721	
LAYSAN	-	-	-	-	-	-	-	-	-	-	63	-	63	
NORTHMAN	-	-	-	-	102	99	817	19	242	18	408	20	1725	
OTHER	421	505	156	220	246	274	83	-	-	-	76	162	2143	
SUMMARY	6583	5326	1356	5283	3457	5374	3276	4365	5541	5815	10400	12324	69100	

TABLE 5. ONAGA CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES "ONAGA"

AREA	MONTH												SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	
HAWAII	1469	1024	348	865	848	1117	1144	3863	1994	1767	6280	7904	28623
BLK	10655	11876	1134	5255	2482	5022	3245	6665	12642	5906	24189	24560	113631
LOAMU	782	1526	76	217	296	699	348	816	1085	919	1364	1832	9960
KMK	14579	12260	2201	9331	1237	4247	620	1688	2496	2310	4740	10629	66338
NIHOA	-	-	-	-	-	-	-	-	-	-	-	68	68
TAHU	-	-	-	445	90	42	-	12	-	-	-	-	589
BECKER	297	1122	1299	-	-	-	-	-	15	14	142	17	2906
BROOKS	-	-	-	150	-	-	-	-	-	1262	-	-	1412
BOGATIEM	-	-	-	-	-	-	-	-	-	-	438	-	438
BARO	-	-	-	-	-	-	-	-	65	-	-	-	65
LAYSAN	-	-	-	-	-	-	-	-	-	-	9	-	9
NORTHAM	-	-	-	-	235	16	114	14	7097	3445	244	36	11201
OTHER	710	443	936	905	269	182	134	-	-	-	-	316	4295
SUMMARY	28492	28651	5994	17168	5457	11325	5605	13058	25344	15623	37406	45362	239535

TABLE 6. ULUA CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES "ULUA"

AREA	MONTH												SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	
HAWAII	3252	1607	313	604	654	1489	806	1325	1499	1498	2210	1586	16843
BLK	2181	700	388	1625	1328	2778	2469	1690	1480	1871	2254	2130	20894
LOAMU	971	814	347	182	491	690	3510	1003	1452	1276	714	2153	13603
KMK	2286	439	59	842	661	714	163	2162	404	316	834	1928	10408
NIHOA	-	-	-	-	-	-	-	-	-	-	-	74	74
TAHU	-	-	-	15	-	147	13	-	-	-	-	-	175
BECKER	286	1144	27	-	-	20	-	-	-	-	149	213	1839
PRIGATE	-	-	-	-	-	-	-	-	124	-	-	-	124
BROOKS	-	-	-	-	-	-	-	-	-	281	-	-	281
BOGATIEM	-	-	-	-	-	-	-	-	-	-	66	-	66
CARDNER	-	-	-	-	-	-	-	-	87	-	-	-	87
RAITA	-	-	-	-	-	-	-	2140	383	414	-	-	2937
LAYSAN	-	-	-	-	-	-	-	-	-	-	4071	-	4071
NORTHAM	-	-	-	-	202	53	2	17	-	-	349	26	689
OTHER	-	2	-	3	7	62	-	-	-	-	-	67	141
SUMMARY	8976	4306	1134	3271	3343	5953	6963	8337	5833	5656	10487	8177	72636

TABLE 7. LEHI CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES LEHI

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	2106	949	103	186	405	616	261	755	754	1824	2715	1504	12210	
BLKS	961	1498	115	861	478	187	50	1094	2125	1274	2766	4488	16101	
OAHU	963	526	16	126	-	-	27	25	67	104	11	138	2003	
KKK	280	71	-	15	-	-	14	56	33	-	16	44	529	
BECKER	-	8	-	-	-	-	-	-	-	-	-	-	8	
OTHER	-	-	-	-	12	-	-	-	-	-	-	-	12	
SUMMARY	4310	3048	234	1188	895	803	360	1930	2979	3202	5500	6414	30871	

TABLE 8. GINDAI CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES GINDAI

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	257	83	24	117	91	103	46	107	69	81	284	170	1432	
BLKS	94	58	4	20	2	81	12	42	47	47	170	86	663	
OAHU	13	17	5	20	14	15	13	14	13	7	15	33	179	
KKK	315	402	39	250	57	114	54	206	224	135	61	131	2072	
HILOA	-	-	-	-	-	-	-	-	-	-	-	105	105	
THAN	-	-	-	63	75	126	53	72	-	-	-	-	389	
BECKER	150	141	58	-	-	172	5	-	61	130	43	97	897	
BROOKS	-	17	-	-	-	-	-	-	-	308	-	-	325	
BOGATIM	-	-	-	-	-	-	-	-	-	-	220	-	220	
GARDMAN	-	-	-	-	-	-	-	-	50	-	-	-	50	
HAITA	-	-	-	-	-	-	-	14	-	-	-	-	14	
HAHO	-	-	-	-	-	-	-	-	174	-	-	11	189	
LAYSAN	-	-	-	-	-	-	-	-	-	-	20	-	20	
MORTINHAS	-	-	-	-	42	80	138	86	21	-	158	-	525	
OTHER	-	-	-	3	-	-	-	-	-	-	34	64	101	
SUMMARY	829	718	130	473	281	691	325	623	663	708	1045	697	7183	

TABLE 9. TAAPE CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES TAAPE

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	1508	1414	429	1162	594	2099	1186	955	766	1300	2411	2087	15951	
ELLS	634	316	262	287	374	1289	794	695	556	285	1270	1273	8135	
OAHU	2451	2743	509	1386	530	896	1405	1137	1942	543	1177	769	15688	
KUK	3876	2889	1813	2813	558	574	1980	2414	259	1305	131	707	19319	
BECKER	-	-	-	-	-	-	-	-	-	351	-	-	351	
FRIGATE	-	-	-	-	-	-	-	-	60	-	-	-	60	
OTHER	-	-	-	36	30	30	-	-	-	-	-	-	96	
SUMMARY	8509	7362	3013	5684	2086	4888	5565	5201	3583	3784	4949	4936	59600	

TABLE 10. BUTAGUCHI CATCHES IN POUNDS BY AREA AND MONTH IN 1985

SPECIES BUTAGUCHI

	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
AREA														
HAWAII	-	-	-	-	4	-	-	-	-	-	1	-	5	
ELKS	-	41	-	-	-	24	8	-	61	-	4	-	138	
OAHU	61	44	-	-	-	-	-	-	-	-	3	37	145	
KKK	91	1161	176	-	17	9	-	1634	394	-	-	265	3747	
TMAN	-	-	-	1637	250	606	439	200	-	-	-	-	3132	
BECKER	1168	1461	407	-	-	858	252	-	-	-	3743	1473	9382	
FRIGATE	652	191	-	-	-	-	-	-	-	-	-	-	843	
BROOKS	-	362	-	400	-	-	-	-	-	2518	-	-	3280	
BOGATIN	-	-	-	-	-	-	-	-	-	-	744	-	744	
CARDNER	-	-	-	-	-	-	-	-	1361	-	-	-	1361	
BAI TA	-	-	-	-	-	-	-	723	-	-	-	-	723	
BARO	-	-	-	-	-	-	-	-	1814	-	-	1673	3487	
BORTHMAN	-	-	-	-	292	1932	8438	1499	2594	334	2404	3403	21576	
OTHER	114	1000	-	-	-	-	-	-	-	-	1300	395	2809	
SUMMARY	2086	4260	583	2037	563	3429	9137	4056	6224	2853	8474	7646	51352	

TABLE 11. WHITE/BLACK ULUA CATCHES IN POUNDS BY AREA AN MONTH IN 1985

SPECIES WHITE/BLACK ULUA

AREA	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
HAWAII	207	78	-	395	121	187	297	22	64	137	250	83	1837	
HLKH	180	138	31	556	30	449	266	389	551	519	601	146	3816	
OAHU	36	16	-	12	55	232	267	40	937	579	124	-	2298	
KKA	-	73	48	-	6	950	101	195	34	125	320	68	1920	
BECKER	-	-	-	-	-	-	-	-	-	-	55	-	55	
BROOKS	-	-	-	-	-	-	-	-	-	755	-	-	755	
LAYSAN	-	-	-	-	-	-	-	-	-	-	9230	-	9230	
NORTHMAN	-	-	-	-	712	1383	6086	3439	-	-	1362	-	12982	
SUMMARY	423	301	79	963	924	3201	7017	4045	1586	2115	11942	297	32893	

TABLE 12. TOTAL CATCH IN POUNDS BY SPECIES AND AREA IN 1985

SPECIES	AREA												
	HAWAII	HLK	OAHU	KKK	MIHOA	TWIN	BECKER	PRIGATE	BROOKS	MOGATIE	GANDY	SAITA	
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	
HAPPOUPOU	4441	4713	9861	18915	374	13731	23469	923	4459	2356	872	1487	
KAHALA	26917	3273	9061	8871	-	-	-	-	-	-	185	311	
KALIKALE	13682	5423	1297	5435	107	519	708	-	181	76	-	97	
OPAKAPAKA	46250	96725	15331	16440	781	19935	34198	7269	7849	2124	2102	585	
OKU	6385	30326	3890	8663	18	94	176	86	104	18	14	25	
OHU	22085	19388	2140	12426	175	2679	3101	-	1449	963	22	20	
OHAGA	28623	113631	9960	66338	68	589	2906	-	1412	438	-	-	
"OLOA"	16843	20894	13603	10808	74	175	1839	128	281	66	47	2937	
LENA	12218	16101	2003	529	-	-	8	-	-	-	-	-	
GINDAI	1432	663	179	2072	105	389	497	-	325	220	50	16	
TAAPU	15951	8135	15688	19319	-	-	351	60	-	-	-	-	
BUTAGUCHI	5	138	145	3747	-	3132	9382	843	3280	724	1361	723	
WHITE/BLACK ULUA	1837	3816	2298	1920	-	-	55	-	755	-	-	-	
SUMMARY	196669	323226	68426	175483	1702	41243	77490	9309	20095	6905	4693	6201	

(CONTINUED)

SPECIES	AREA				SUMMARY
	HAWAII	LAYSAN	ORTHMAN	OTHER	
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	
	SUM	SUM	SUM	SUM	
HAPPOUPOU	3423	695	7707	9938	98689
KAHALA	-	-	23	80	40574
KALIKALE	-	-	863	298	29672
OPAKAPAKA	4785	-	36834	12310	303518
OKU	-	-	63	4869	54731
OHU	721	63	1725	2143	69100
OHAGA	65	9	11201	4295	239535
"OLOA"	-	4071	689	141	72636
LENA	-	-	-	12	30471
GINDAI	189	20	525	101	7183
TAAPU	-	-	-	96	59600
BUTAGUCHI	3487	-	21574	2809	51352
WHITE/BLACK ULUA	-	9230	12982	-	32493
SUMMARY	12670	14088	94184	37046	1089554

TABLE 13. TOTAL CATCH IN POUNDS BY SPECIES AND MONTH IN 1985

SPECIES	MONTH													SUMMARY
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT	WEIGHT		
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM		
HAPUOPOU	14819	14469	5412	6991	4269	6732	4757	4073	7746	6071	11339	8211	98889	
KAHALA	9994	4885	656	2498	2097	4793	1104	3785	2290	1211	4009	3252	40574	
KALEKALE	4563	2634	462	1006	794	1409	1863	1613	2847	1767	4368	5346	28672	
OPAKAPAKA	49323	38069	4167	12364	11581	12432	20031	15922	23834	18085	50527	47143	303518	
UKU	6107	1376	127	1920	7033	11206	5706	4134	4631	2894	3133	6464	54731	
KU	6583	5326	1356	5283	3457	5374	3276	4365	5541	5815	14400	12324	69100	
OHAGA	28492	28651	5998	17168	5457	11325	5405	13058	25394	15623	37406	45362	239535	
"OLOA"	8976	4306	1134	3271	3343	5953	4963	8337	5833	5656	10687	4177	72636	
LENI	4310	3048	234	1188	895	803	360	1930	2979	3202	5504	6414	30871	
GINDAI	829	718	130	473	281	691	325	623	663	708	1045	697	7183	
TAAPE	8509	7362	3013	5684	2086	4888	5565	5201	3583	3744	4969	4936	59600	
BUTAGUCHI	2086	4260	583	2037	563	3429	9137	4056	6224	2853	4474	7646	51352	
WHITE/BLACK OLOA	423	301	79	963	924	3201	7017	4045	1586	2115	11942	297	32893	
SUMMARY	145014	115405	23347	60446	42780	72236	71709	75182	93151	69784	163831	158349	1089554	

TABLE 14. TOTAL CATCH IN POUNDS BY SPECIES AND GEAR TYPE IN 1985

SPECIES	GEAR		SUMMARY
	HANDLINE	OTHER	
	WEIGHT	WEIGHT	
	SUM	SUM	
HAPUOPOU	98746	143	98889
KAHALA	37132	3442	40574
KALEKALE	24271	401	28672
OPAKAPAKA	302669	849	303518
UKU	53747	984	54731
KU	68833	267	69100
OHAGA	239189	346	239535
"OLOA"	56432	16204	72636
LENI	30096	777	30871
GINDAI	7179	4	7183
TAAPE	30132	29668	59600
BUTAGUCHI	51283	69	51352
WHITE/BLACK OLOA	25016	7877	32893
SUMMARY	1024723	60831	1089554

FIGURE 1. RELATIVE CPUE IN THE MAIN HAWAIIAN ISLANDS IN 1985

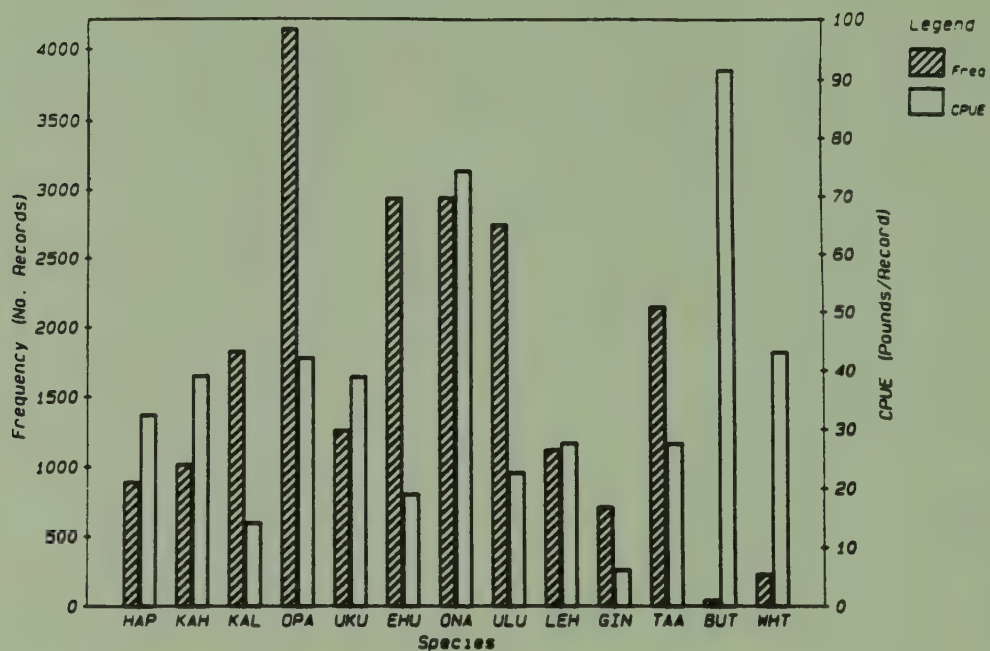


FIGURE 2. RELATIVE CPUE IN THE NWHI IN 1985

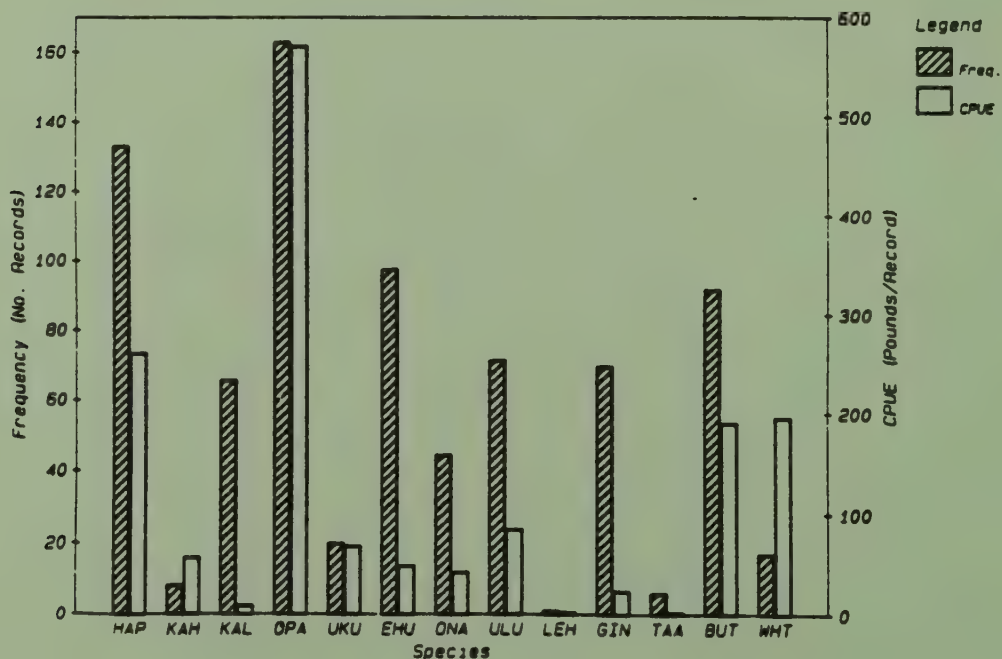


FIGURE 3. TOTAL MANAGEMENT UNIT SPECIES CATCH BY ZONE IN 1985

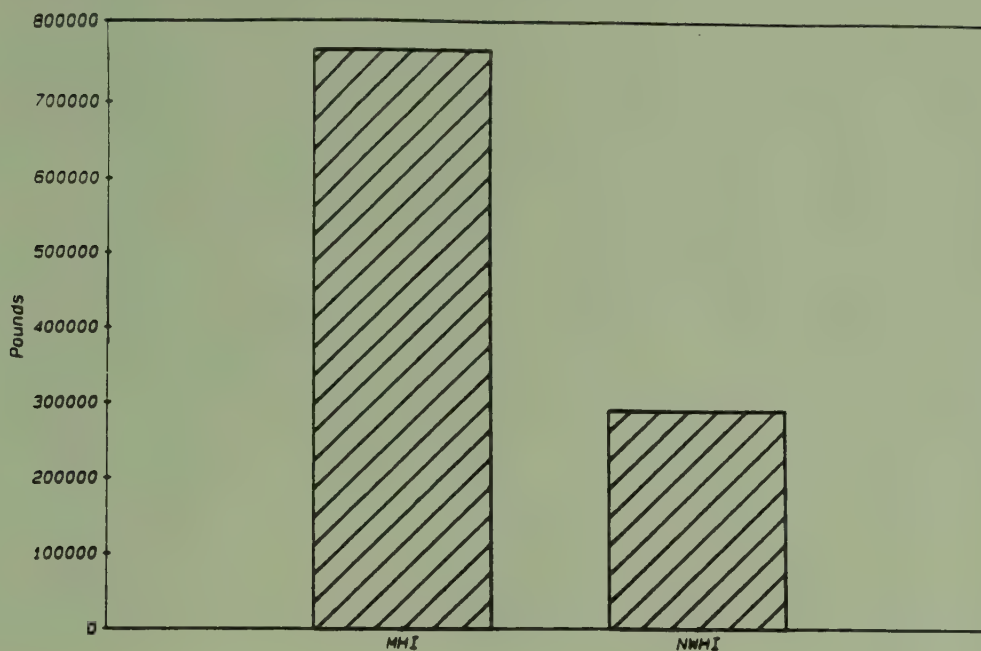


FIGURE 4. TOTAL MONTHLY CATCHES BY ZONE IN 1985

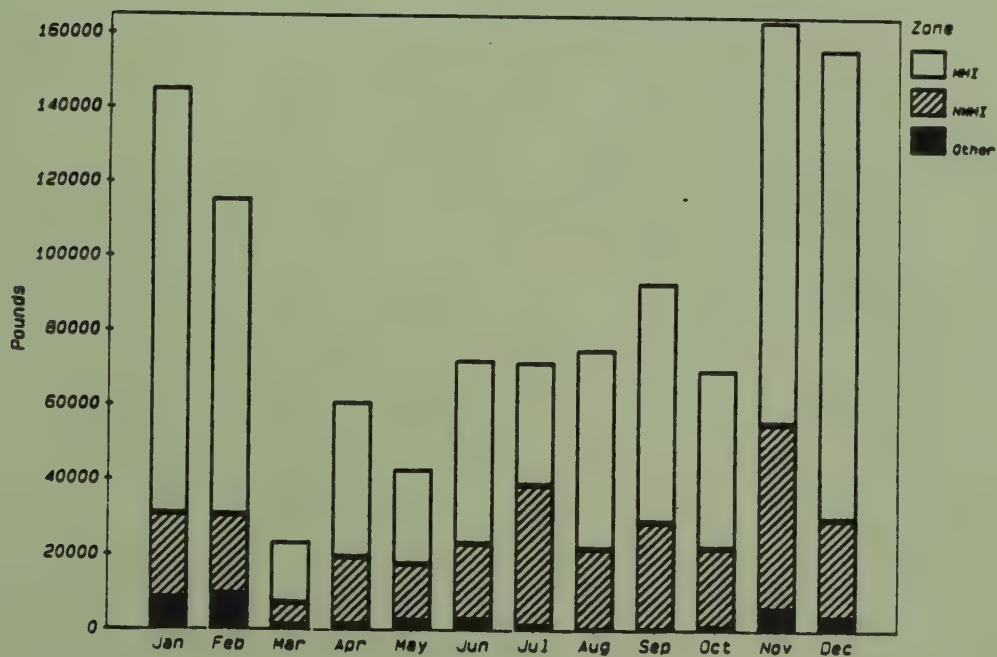


FIGURE 5. CATCH BY GEAR AND SPECIES IN 1985

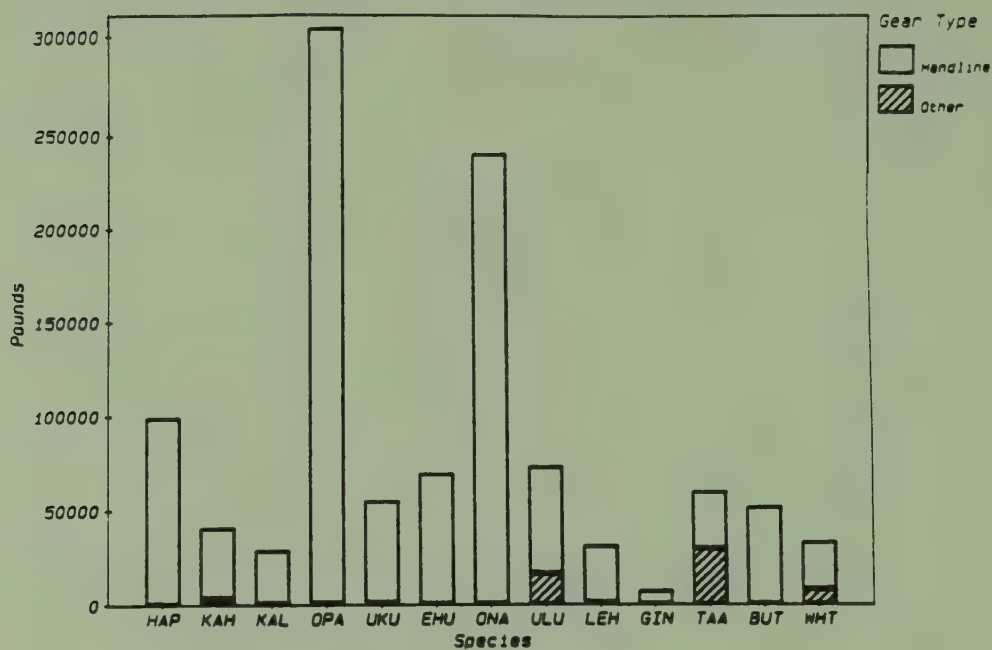


FIGURE 6. TOTAL MANAGEMENT UNIT SPECIES CATCH BY ZONE

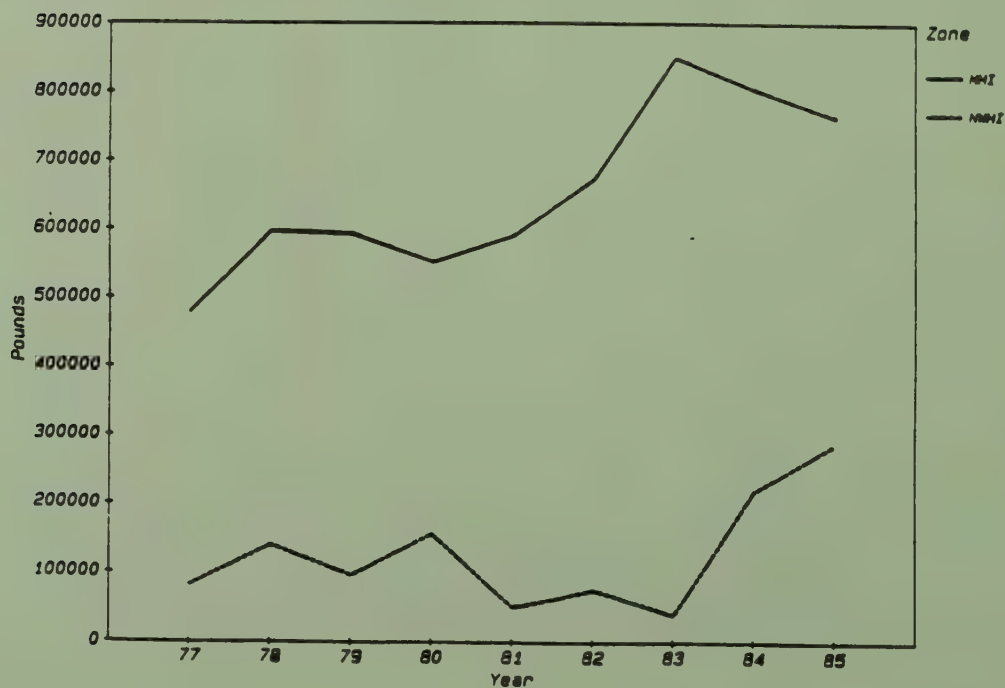


TABLE 15. KALEKALE CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species Kalekale

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Alsea														
Hawaii	1289	1181	1110	1071	615	2871	1631	2091	4551	2941	2071	9691	70461	
MLK	14511	4871	3121	1601	2041	1441	3601	2801	6891	11601	8101	27371	87941	
Oahu	631	611	561	251	171	321	241	181	111	851	2611	7521	14051	
KMK	6931	2111	4201	191	841	81	241	1081	1861	2191	4591	6941	31251	
Minoa	831	-1	551	921	3791	61	211	1151	2301	1531	-1	-1	11341	
Necker	851	-1	421	-1	-1	271	-1	-1	581	81	451	-1	2451	
Frigate	-1	-1	-1	-1	-1	-1	-1	-1	5001	-1	-1	-1	5001	
Brooks	-1	-1	-1	-1	-1	-1	-1	-1	-1	2501	31	451	2981	
Boydston	501	-1	-1	-1	-1	-1	-1	-1	21	-1	-1	-1	521	
Balta	-1	-1	171	-1	-1	-1	-1	2251	101	-1	41	-1	2541	
Naro	-1	-1	-1	-1	-1	-1	-1	151	-1	-1	-1	-1	151	
Laysan	-1	-1	-1	-1	-1	-1	-1	351	-1	-1	-1	-1	351	
Northham	551	-1	411	581	-1	-1	-1	-1	-1	-1	-1	-1	1541	
Pioneer	-1	-1	-1	-1	-1	-1	-1	-1	-1	741	51	-1	791	
Lisianski	-1	-1	-1	-1	-1	31	-1	-1	-1	701	-1	11	741	
Other	71	-1	181	-1	-1	381	611	-1	-1	-1	-1	-1	1241	
Summary	37761	19001	20711	6611	12991	5451	6531	10051	21411	23131	17721	51981	233341	

TABLE 16. OPAKAPAKA CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species Opakapaka

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Alsea														
Hawaii	50151	58221	68351	11531	17301	7121	20441	7551	35711	25911	38231	115691	456241	
MLK	140611	90571	61301	11171	25051	12291	42601	80441	154751	138451	120461	285301	1163811	
Oahu	33021	29491	22561	3391	4361	1191	2051	6391	4251	3961	12011	42751	169421	
KMK	22911	14381	4331	2191	8031	451	33251	30731	53681	15781	3741	45661	235131	
Minoa	6241	-1	1431	6871	2711	3501	341	651	3401	7851	-1	-1	33391	
Twin	-1	791	-1	-1	-1	-1	-1	2321	-1	-1	-1	-1	3111	
Necker	19621	14321	8091	-1	551	4771	12071	-1	871	131	321	-1	59741	
Frigate	32001	-1	3771	20201	48121	46261	36541	38291	54361	30531	-1	2541	312611	
Brooks	37201	-1	30241	-1	-1	-1	-1	-1	1521	1131	151	7131	77371	
Boydston	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	25061	-1	25061	
Gardner	-1	-1	-1	-1	-1	2151	27571	-1	-1	5251	5251	-1	40221	
Balta	-1	-1	1571	21551	-1	3301	4701	36171	49081	-1	90041	-1	206411	
Naro	-1	-1	171	-1	-1	4511	5211	8121	7001	-1	-1	-1	25011	
Laysan	-1	-1	-1	-1	-1	-1	-1	161	-1	-1	-1	-1	161	
Northham	42661	3611	10191	10511	-1	-1	-1	-1	-1	20341	-1	-1	87311	
Pioneer	-1	-1	-1	-1	-1	-1	-1	-1	-1	6111	16441	-1	22591	
Lisianski	-1	-1	-1	-1	-1	8381	-1	-1	22901	17731	-1	70741	119751	
Other	801	7371	1561	-1	-1	4421	791	-1	-1	-1	-1	-1	14941	
Summary	384231	218751	213561	87411	106121	98341	185601	211221	391921	273571	311741	569811	3052271	

TABLE 17. UKU CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species UKU

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Area														
Hawaii	793	75	321	1256	2004	591	5297	4288	2572	3484	431	1254	22366	
MLKM	3294	2443	2430	1202	9191	6207	5413	3380	2448	1031	877	2200	40120	
Oahu	74	53	85	836	2186	1026	1026	511	1115	393	244	154	7705	
KMK	1640	630	136	354	2708	1409	3044	10634	5861	4378	2100	962	31856	
Mahoa	13	-	-	-	-	15	-	14	-	82	-	-	124	
Wecker	17	200	11	-	-	-	-	-	-	771	-	-	999	
Frigate	700	-	-	-	-	-	22	84	-	-	-	-	406	
Brooks	500	-	-	-	-	-	-	-	-	17	-	-	517	
Other	-	19	-	-	-	-	-	-	-	-	-	-	19	
Summary	7037	3420	2983	3648	16089	9248	14802	18911	11996	10156	3652	4570	106512	

TABLE 18. EHU CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species EHU

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun		
Area														
Hawaii	4463	2364	1754	1322	1497	741	760	230	975	764	491	2302	17667	
MLKM	2795	2246	1324	657	909	780	950	975	1383	1289	1389	2869	17566	
Oahu	259	199	92	10	322	93	130	45	309	120	3103	519	5209	
KMK	1214	1318	579	186	775	257	645	395	1691	1042	810	897	9809	
Mahoa	-	-	206	77	366	-	13	722	20	23	-	-	1427	
Iwin	-	137	-	-	-	-	-	90	-	-	-	-	227	
Wecker	549	500	63	-	9	481	6	-	-	2	25	-	1634	
Frigate	500	-	148	99	47	48	395	227	434	-	-	-	1898	
Brooks	100	-	-	-	-	-	-	-	3	335	32	55	525	
Bojatiea	-	-	-	-	-	-	-	-	14	-	-	-	14	
Baita	-	-	167	-	-	-	-	229	78	-	59	-	533	
Naro	-	-	-	-	-	-	8	40	-	-	-	-	48	
Laysan	-	-	-	-	-	-	-	360	15	-	-	-	375	
Northham	5	11	47	36	-	-	-	-	-	222	-	-	321	
Pioneer	-	-	-	-	-	-	-	-	-	456	562	-	1018	
Lisianski	-	-	-	-	-	198	-	-	494	295	-	422	1409	
Other	61	52	61	-	-	-	419	-	-	-	-	-	591	
Summary	9945	6831	4441	2387	3925	2598	3326	3313	5416	4556	6471	7064	60273	

TABLE 19. ONAGA CATCHES IN POUNDS BY AREA AND MONTH IN 1986

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Area														
Hawaii	2799	1625	1258	1131	965	583	1591	257	2728	1397	1732	4368	20433	
RLKM	27134	9015	4078	1167	1717	2621	4691	4797	12695	11551	7989	12271	92726	
Janu	3063	312	227	25	21	79	167	497	1017	764	3152	8975	18299	
KMK	10370	1155	690	406	3074	306	930	639	4471	3766	2977	6870	35654	
Nihoa	222	-	790	874	1038	13	-	97	196	237	-	-	3467	
Ivlu	-	268	-	-	-	-	-	10	-	-	-	-	278	
Necker	268	100	12	-	-	59	-	6344	1268	-	330	-	8381	
Frigate	1000	-	50	-	3243	3578	10300	8551	5694	3408	-	7567	43381	
Brooks	1000	-	-	-	-	-	-	-	1208	767	-	3487	6462	
Hogation	-	-	-	-	-	-	-	-	30	-	1709	-	1739	
Gardner	-	-	-	-	-	-	1200	-	-	-	-	-	1200	
Balta	-	-	-	-	-	-	-	70	94	-	171	-	335	
RATO	-	-	-	-	-	-	-	5	-	-	-	-	5	
Laysan	-	-	-	-	-	-	-	20	15	-	-	-	35	
Northham	5	707	-	568	-	-	-	-	-	1668	-	-	2948	
Pioneer	-	-	-	-	-	-	-	-	-	901	1356	-	2257	
Lesianski	-	-	-	-	-	-	-	-	498	381	-	170	1057	
Other	87	18	418	-	-	-	254	-	-	117	-	-	894	
Summary	38947	13200	7521	4171	10058	7239	19133	21287	29904	24957	19416	43716	239551	

TABLE 20. ULUA CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species "Ilua"

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Area														
Hawaii	3862	592	1306	1032	1500	625	760	1283	1768	2471	1193	2490	18882	
RLKM	2083	747	1618	1460	2331	2976	2456	1909	2722	1639	876	1320	22137	
Janu	454	346	496	2936	3250	1537	1951	667	3595	2245	1529	768	19774	
KMK	1286	733	413	259	1000	637	1479	2621	6377	2349	1749	1844	20747	
Nihoa	-	-	-	-	43	-	26	109	-	239	-	-	417	
Ivlu	-	-	-	-	-	-	-	34	-	-	-	-	34	
Hecker	276	-	11	-	53	-	54	-	-	42	-	-	436	
Frigate	-	-	-	-	677	-	-	-	21	-	-	-	679	
Brooks	-	-	-	-	-	-	-	-	-	-	17	-	17	
Balta	-	-	-	-	-	-	-	535	-	-	103	-	638	
Northham	627	5	42	13	-	-	-	-	-	-	-	-	687	
Pioneer	-	-	-	-	-	-	-	-	-	18	-	-	18	
Lisianski	-	-	-	-	-	16	-	-	-	8	-	70	94	
Other	-	7	-	-	-	-	7	-	-	-	-	-	18	
Summary	8588	2430	3886	5700	8854	5791	6733	7158	14464	9011	5467	6492	84574	

TABLE 21. LEHI CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species Lehi	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Summary
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Acua													
Hawaii	1439	1139	876	312	262	232	201	16	565	235	268	2630	8175
HLN	978	630	613	8	57	47	189	615	2783	1619	1253	4705	13497
Oahu	432	173	49	-	-	-	23	14	-	-	182	204	1077
KKK	34	-	-	23	-	6	22	16	13	42	63	80	307
Summary	2883	1942	1538	343	319	285	435	661	3361	1896	1766	7627	23056

TABLE 22. GINDAI CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species Gindai	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Summary
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Acua													
Hawaii	201	128	150	22	78	72	19	23	76	18	20	147	958
HLN	97	110	93	16	40	44	8	49	23	32	57	151	720
Oahu	19	9	21	6	49	8	11	-	8	4	5	18	157
KKK	70	42	17	6	105	-	58	94	130	166	83	90	861
Mihoo	-	-	28	49	98	4	-	131	-	3	-	-	313
Twin	-	2	-	-	-	-	-	-	-	-	-	-	2
Wacker	164	-	9	-	4	26	64	-	-	-	-	-	267
Frigate	-	-	-	13	-	-	136	6	31	-	-	-	186
BOOKS	-	-	-	-	-	-	-	-	-	23	12	-	35
Kaita	-	-	32	-	-	-	-	99	60	-	67	-	258
Harco	-	-	-	-	-	-	-	33	-	-	-	-	33
Laysan	-	-	-	-	-	-	-	-	10	-	-	-	10
Northham	10	71	29	41	-	-	-	-	-	145	-	-	296
Pioneer	-	-	-	-	-	-	-	-	-	228	204	-	432
Lisianski	-	-	-	-	-	72	-	-	379	127	-	88	666
Other	7	24	-	-	-	-	34	-	-	-	-	-	61
Summary	563	386	379	153	374	226	330	435	717	746	448	494	5251

TABLE 23. TAAPE CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species: taape

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area		
Hawaii	1676	1751	1948	253	765	768	641	389	502	692	239	1275	10899	
MLKM	1352	1416	506	179	903	488	813	642	775	894	885	1711	10524	
Oahu	1419	195	944	1083	4712	1589	1616	946	5478	2625	682	401	21690	
KMa	145	1075	247	74	278	339	231	880	1679	1536	1499	1985	10368	
BROOKS	-	-	-	-	-	-	-	-	-	1	-	-	1	
Northham	-	-	3	-	-	-	-	-	-	-	-	-	3	
Summary	4592	4437	3688	1589	6658	3144	3301	2857	8434	5748	3705	5372	53485	

TABLE 24. BUTAGUCHI CATCHES IN POUNDS BY AREA AND MONTH IN 1986

Species: butaguchi

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Area														
Hawaii	-	-	44	-	-	-	-	-	-	-	-	-	44	
ALKN	-	-	-	-	30	11	3	8	10	-	-	134	196	
Oahu	65	20	11	110	1	-	9	-	-	-	47	191	454	
AKK	78	1865	-	30	121	-	1777	3625	1852	2638	10	6026	18725	
Mihoo	-	-	-	1323	163	52	-	340	-	85	-	-	2749	
Twin	-	-	-	-	-	-	-	95	-	-	-	-	95	
Necker	2007	1500	987	-	-	28	94	-	-	-	-	-	5463	
Private	2000	-	-	-	383	898	1347	1392	215	3770	-	327	12268	
BROOKS	1000	-	646	-	-	-	-	-	-	6	45	219	1916	
Hogatien	699	-	-	-	-	-	-	-	100	-	695	-	1493	
Gardner	-	-	-	-	-	70	563	-	-	150	150	-	933	
Malta	-	-	497	423	-	200	207	1618	95	-	4352	-	8248	
Maro	-	-	-	-	-	425	313	2155	2050	-	-	-	4943	
Laysan	-	-	-	-	-	-	-	210	30	-	-	-	240	
Northham	351	-	2299	153	-	-	-	-	-	774	-	-	8135	
Pioneer	-	-	-	-	-	-	-	-	-	1483	1411	-	2894	
Lisianski	-	-	-	-	-	393	-	-	767	223	-	393	1776	
Other	-	1678	-	-	-	23	76	-	-	-	-	-	1777	
Summary	10082	5063	4444	3417	698	2100	5246	9463	7911	9895	6710	7290	72349	

TABLE 25. WHITE/BLACK ULUA CATCHES IN POUNDS BY AREA AN MONTH IN 1986

Species white/black ulua

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Area														
Hawaii	79	188	56	81	-	-	-	105	96	71	33	68	733	
BLAM	308	275	247	215	671	207	576	947	661	655	166	264	5192	
Oahu	1098	127	33	5	-	10	70	142	783	3529	-	29	5822	
KMa	187	235	-	-	-	-	88	500	916	621	-	488	3031	
Kaita	-	-	-	-	-	-	-	1445	-	-	38	-	1483	
Lisianski	-	-	-	-	-	-	-	-	-	148	-	2197	2345	
Other	-	205	-	-	-	-	-	-	-	-	-	-	205	
Summary	1663	986	336	301	671	217	734	3139	2456	5024	237	3042	18811	

TABLE 26. TOTAL CATCH IN POUNDS BY SPECIES AND AREA IN 1986

Species	Area												
	Hawaii	MLKM	Oahu	KMK	Mihua	Twin	Necker	Frigate	Brooks	Hogatten	Gardner	Maui	
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Hapuepue	3063	5434	624	22505	7802	260	8482	9080	436	2030	767	12386	
Kahala	19302	6326	2032	10720	-	-	89	-	-	-	-	-	-
Kalekale	7046	8734	1405	3125	1134	-	245	500	298	52	-	254	
Opakapaka	45624	116381	16942	23513	3339	311	5974	31261	7737	2506	4022	20641	
Uku	22366	40120	7705	33856	124	-	999	806	517	-	-	-	-
Ihu	17667	17566	5209	9809	1427	227	1634	1898	525	14	-	533	
Onaga	20433	92726	18299	35654	3467	278	8381	43381	6462	1739	1200	335	
"Ulua"	18882	22137	19774	20747	417	34	436	679	17	-	-	638	
Lehi	8175	13497	1077	307	-	-	-	-	-	-	-	-	-
Gindai	954	720	157	861	313	2	267	186	35	-	-	258	
Taape	10899	10524	21690	10368	-	-	-	-	1	-	-	-	-
Butaguchi	44	196	454	18725	2749	95	5463	12268	1916	1493	933	8248	
White/black Ulua	733	5192	5822	3031	-	-	-	-	-	-	-	1483	
Summary	175148	339613	101190	193221	20772	1207	31970	100059	21869	7834	6922	44776	

(CONTINUED)

Species	Area							Summary
	Maui	Laysan	Northham	Pioneer	Lisianski	Other		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Hapuepue	739	615	6564	9260	7764	1721	103457	
Kahala	-	-	-	-	-	25	38894	
Kalekale	15	35	154	79	74	124	23334	
Opakapaka	2501	16	8731	2259	11975	1494	305227	
Uku	-	-	-	-	-	19	106512	
Ihu	48	375	321	1018	1409	593	60273	
Onaga	5	35	2948	2257	1057	894	239551	
"Ulua"	-	-	687	18	94	14	86574	
Lehi	-	-	-	-	-	-	23056	
Gindai	33	10	296	432	666	61	5251	
Taape	-	-	31	-	-	-	53405	
Butaguchi	4943	240	8135	2894	1776	1777	72349	
White/Black Ulua	-	-	-	-	2345	205	18811	
Summary	4284	1326	27839	18217	27160	6927	1130374	

TABLE 27. TOTAL CATCH IN POUNDS BY SPECIES AND MONTH IN 1986

	Month													Summary
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight		
	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		
Species														
Hapupuu	11981	9931	12244	3980	4282	4692	9213	11639	8825	15758	7499	3513	103457	
Kanala	5682	4534	4033	2831	7438	2831	2104	1018	1583	2148	1470	2842	38494	
Kalekale	3776	1900	2071	661	1299	545	653	1005	2141	2313	1772	5198	23334	
Opakapaka	38423	21875	21356	8741	10612	9834	18560	21122	39192	27357	31174	54981	305227	
Uku	7037	3420	2983	3648	16089	9248	14802	18911	11996	10156	3652	4570	106512	
Ehu	3945	6831	4441	2387	3925	2598	3326	3313	5416	4556	6471	7064	60273	
Onaga	38947	13200	7523	4171	10058	7239	19133	21287	29904	24957	19416	43716	239551	
"Ulua"	8588	2430	3886	5700	8854	5791	6733	7158	14464	9011	5467	6492	84574	
Lehi	2843	1942	1538	343	319	285	435	661	3361	1896	1766	7627	23056	
Gindai	563	386	379	153	374	226	330	435	717	746	448	494	5251	
Taape	4592	4437	3648	1589	6658	3144	3301	2857	8434	5748	3705	5172	53485	
Batayuchi	10082	5063	4484	3417	698	2100	5236	9463	7911	9895	6710	7290	72349	
White/Black Ulua	1668	986	336	301	671	217	734	3139	2456	5024	237	3042	18811	
Summary	144067	76935	68922	37922	71277	48750	84560	102008	136400	119565	89787	154181	1134374	

TABLE 28. TOTAL CATCH IN POUNDS BY SPECIES AND GEAR TYPE IN 1986

Species	Gear		Summary
	Handline	Other	
	Weight	Weight	
	Sum	Sum	
Hapupuu	102464	993	103457
Kahala	31769	4725	38494
Kalekale	23083	251	23334
Opakapaka	298620	6607	305227
Uku	103918	2594	106512
Ehu	56513	3760	60273
Onaga	235764	3767	239551
"Ulua"	60135	24439	84574
Lehi	21691	1365	23056
Gindai	5251	-	5251
Taape	29429	24056	53485
Bataguchi	71819	530	72349
White/Black Ulua	9111	9700	18811
Summary	1051567	82807	1134374

FIGURE 7. RELATIVE CPUE IN THE MAIN HAWAIIAN ISLANDS IN 1986

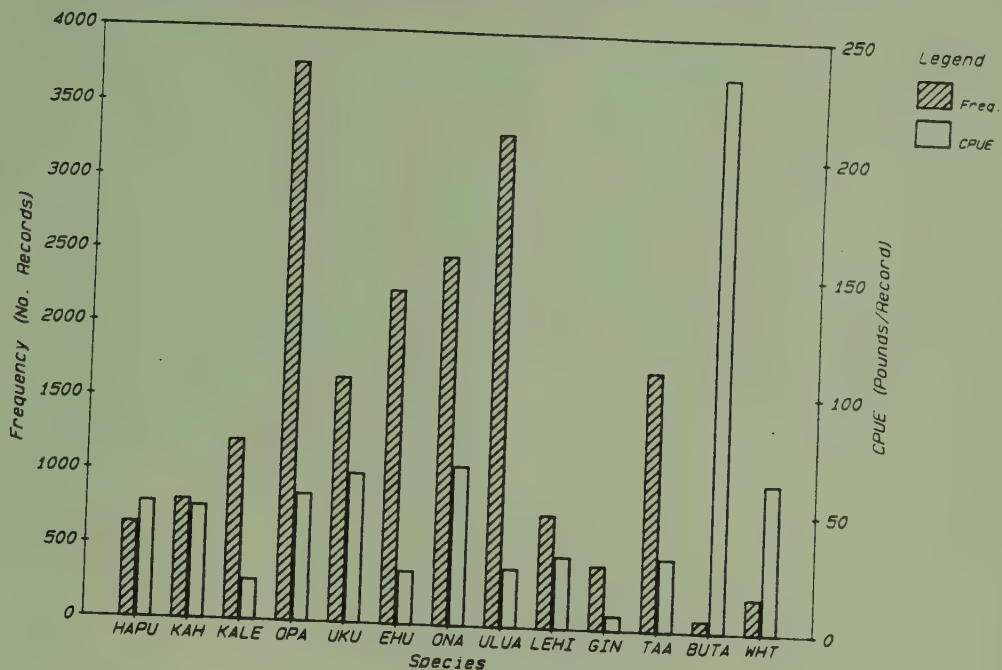


FIGURE 8. RELATIVE CPUE IN THE NWHI IN 1986

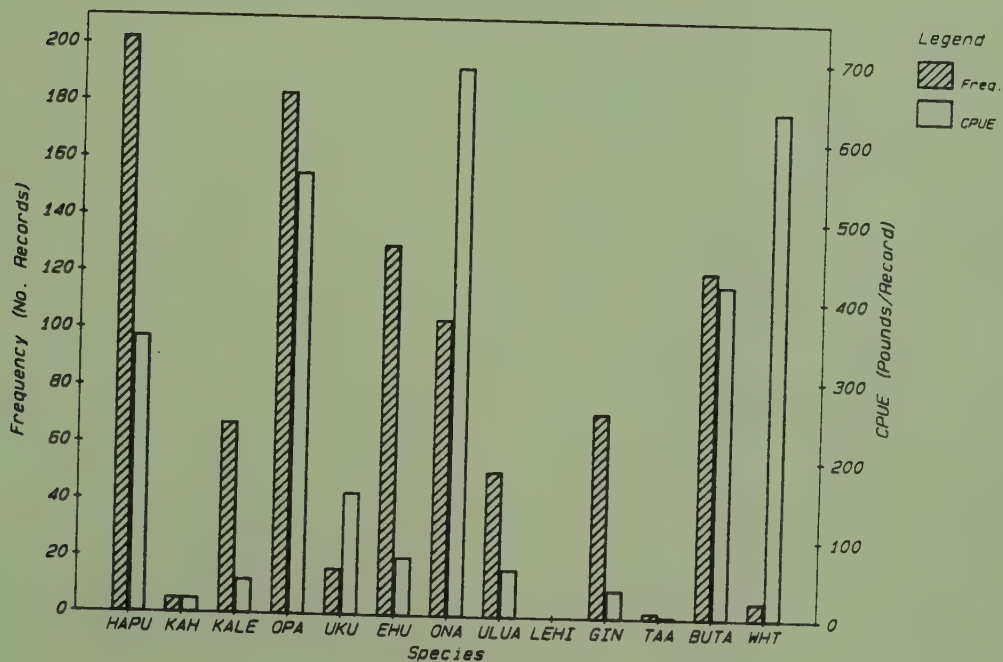


FIGURE 9. TOTAL MANAGEMENT UNIT SPECIES CATCH BY ZONE IN 1986

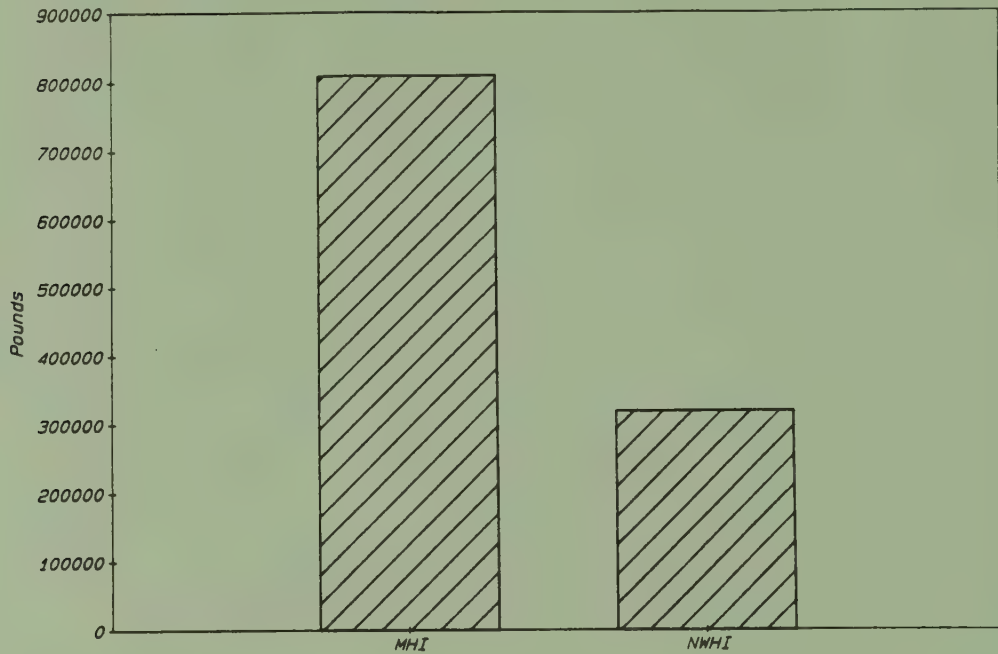


FIGURE 10. TOTAL MONTHLY CATCHES BY ZONE IN 1986

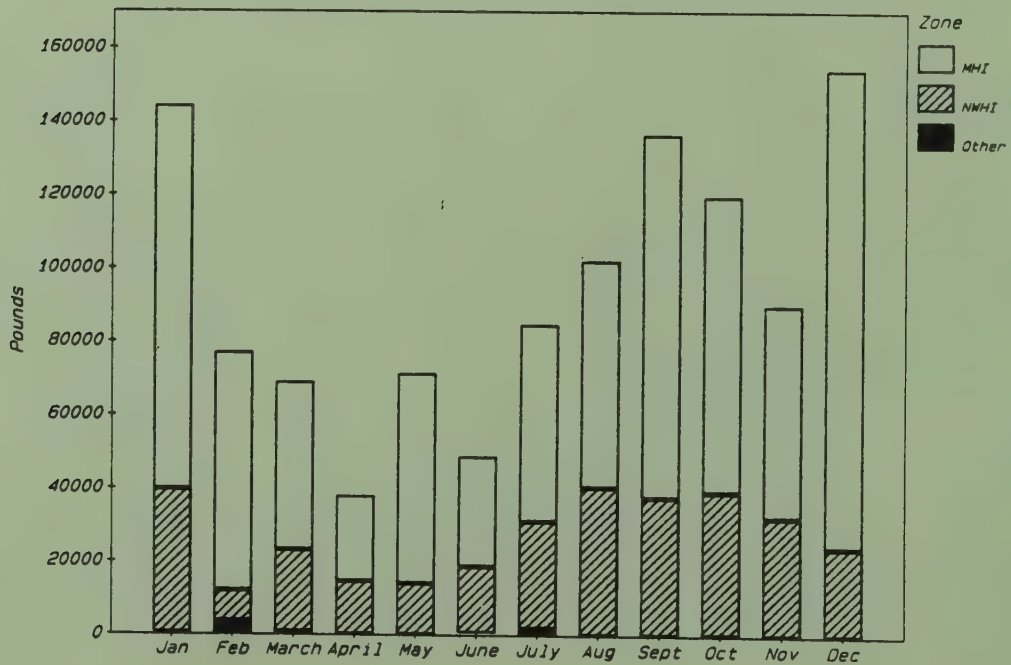


FIGURE 11. CATCH BY GEAR AND SPECIES IN 1986

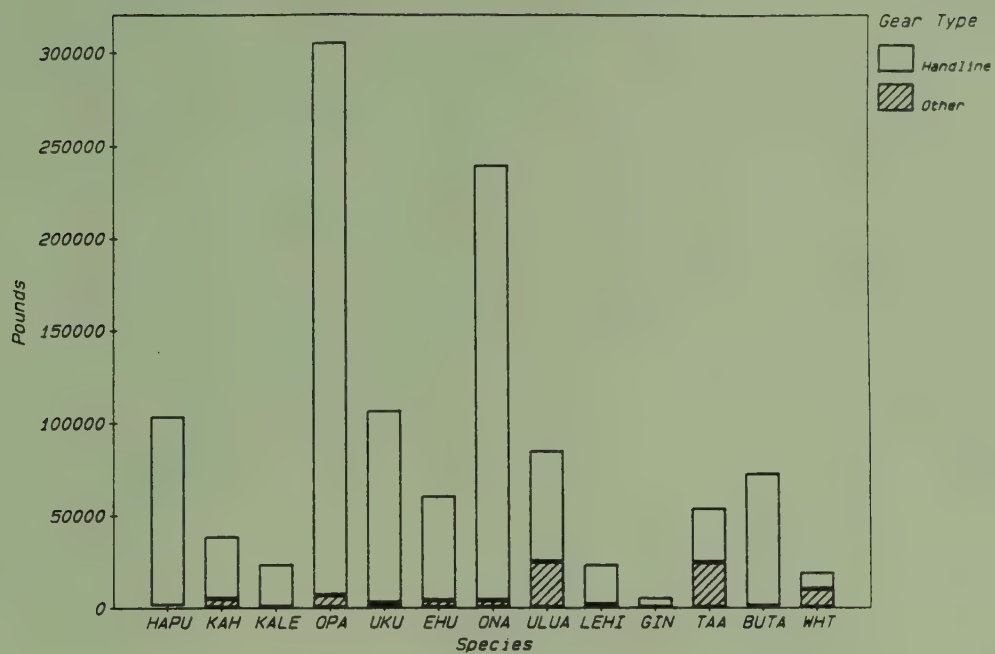


FIGURE 12. MEAN MONTHLY AND DAILY CATCH

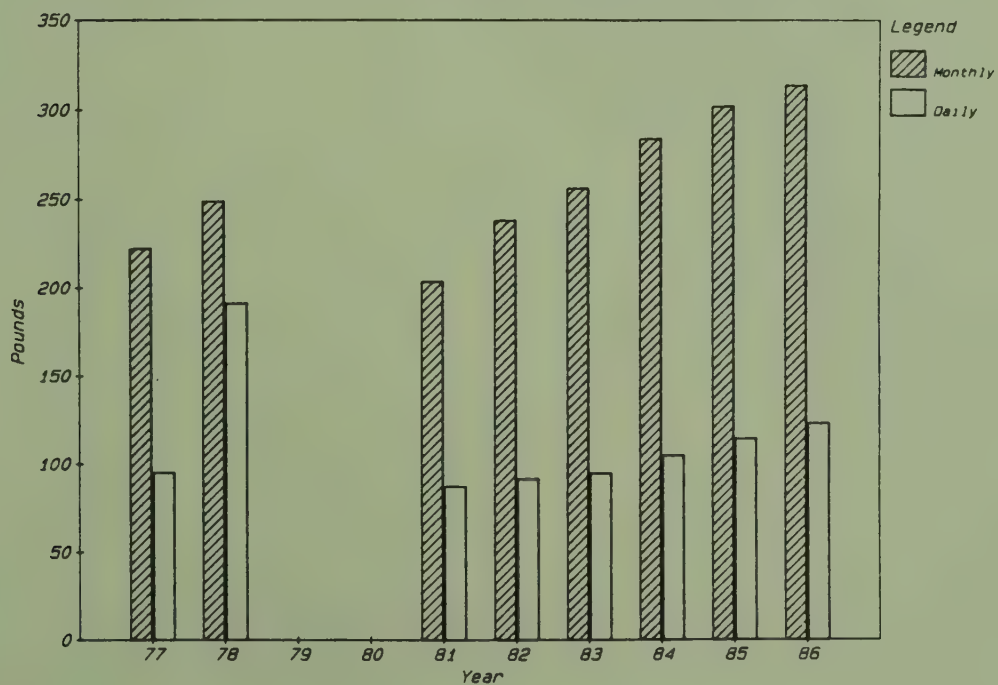


FIGURE 13. HAPUUPUU CATCH AND CPUE

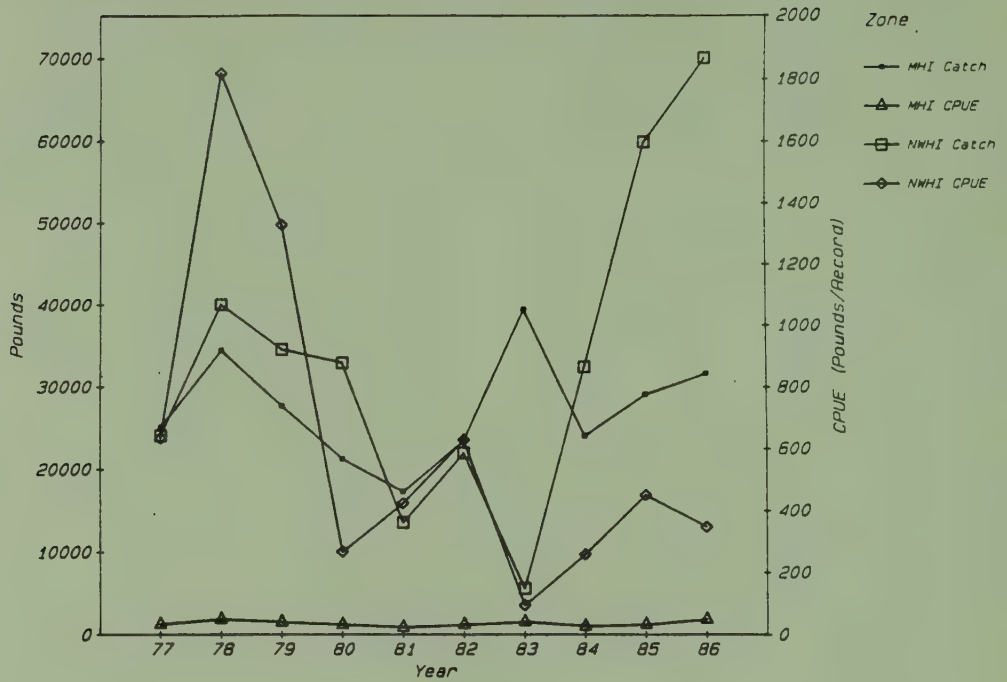


FIGURE 14. KAHALA CATCH AND CPUE

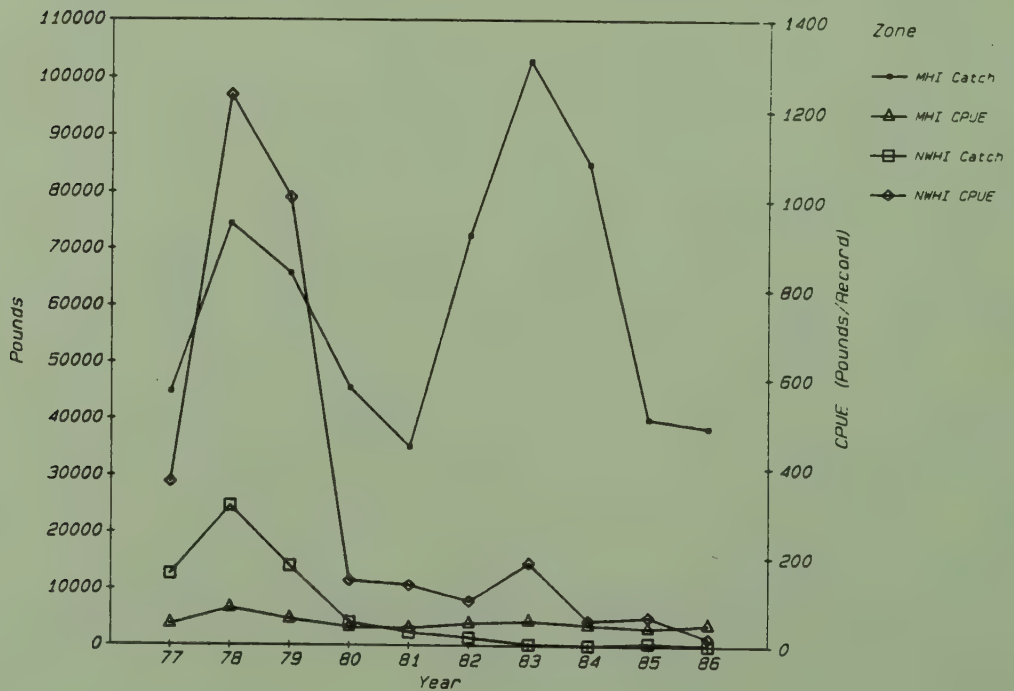


FIGURE 15. KALEKALE CATCH AND CPUE

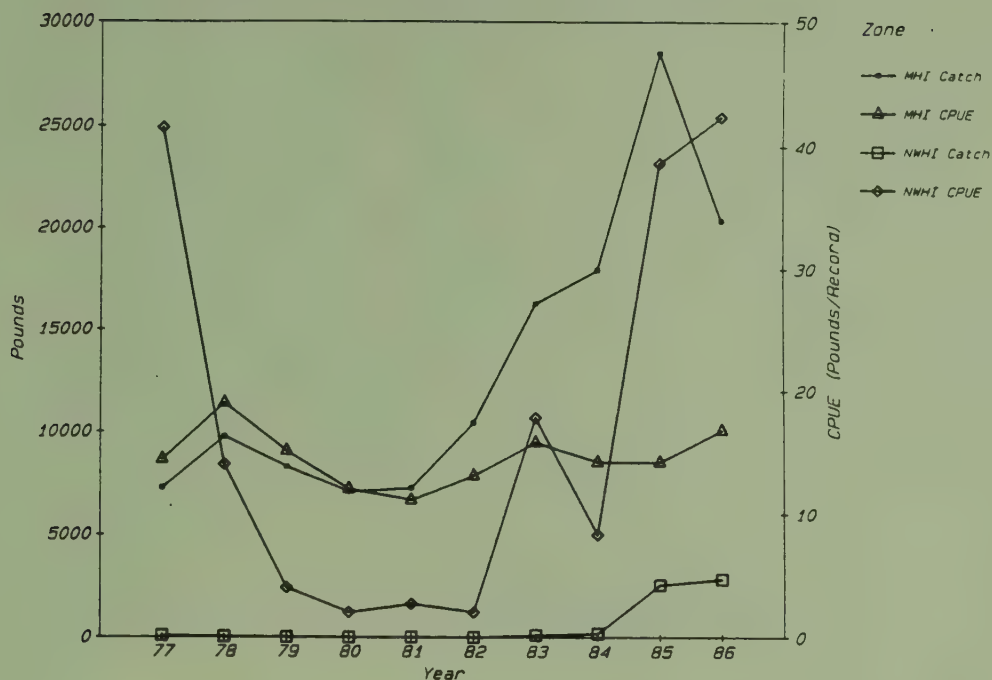


FIGURE 16. OPAKAPAKA CATCH AND CPUE

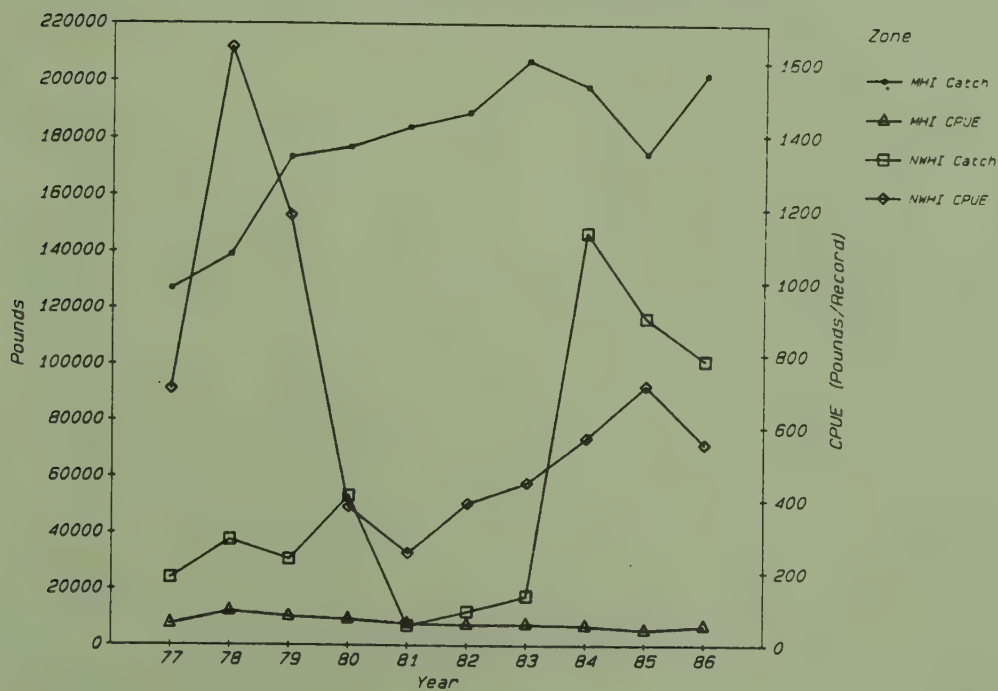


FIGURE 17. UKU CATCH AND CPUE

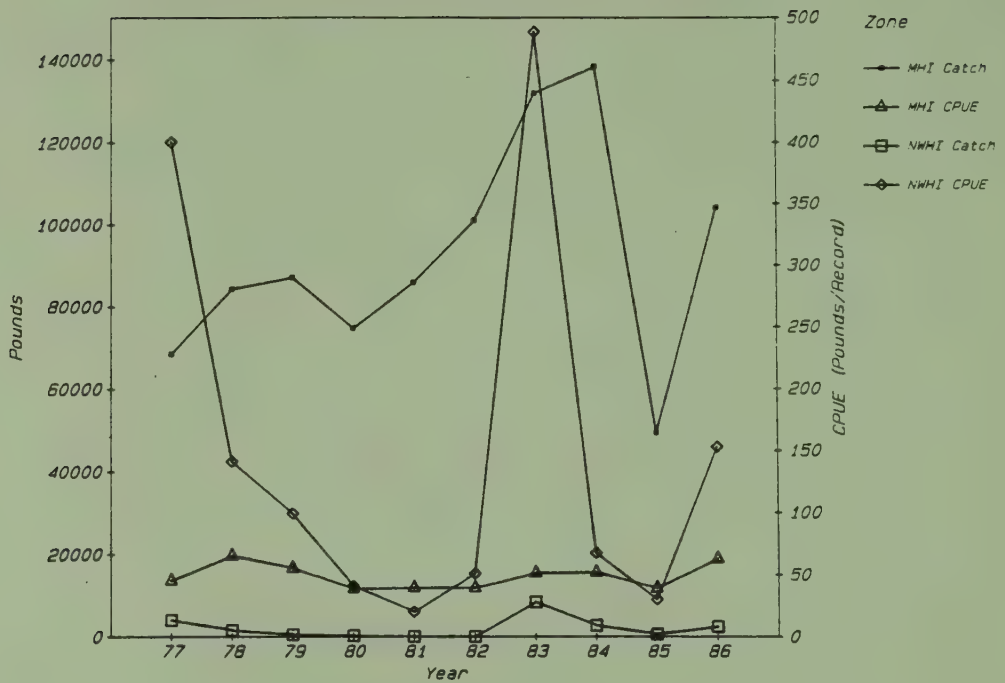


FIGURE 18. EHU CATCH AND CPUE

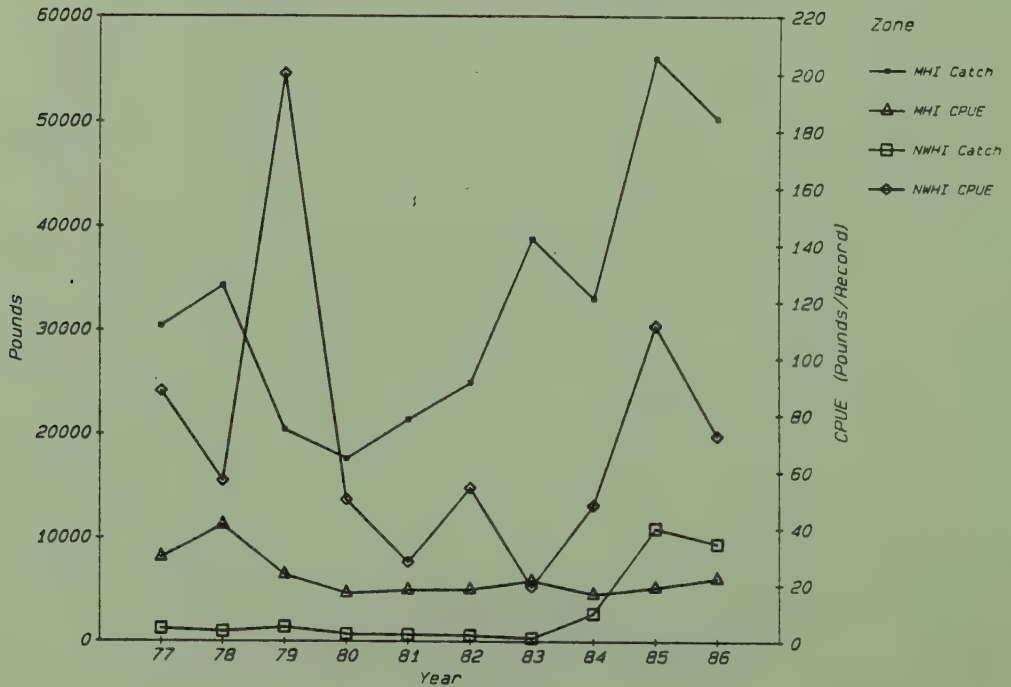


FIGURE 19. ONAGA CATCH AND CPUE

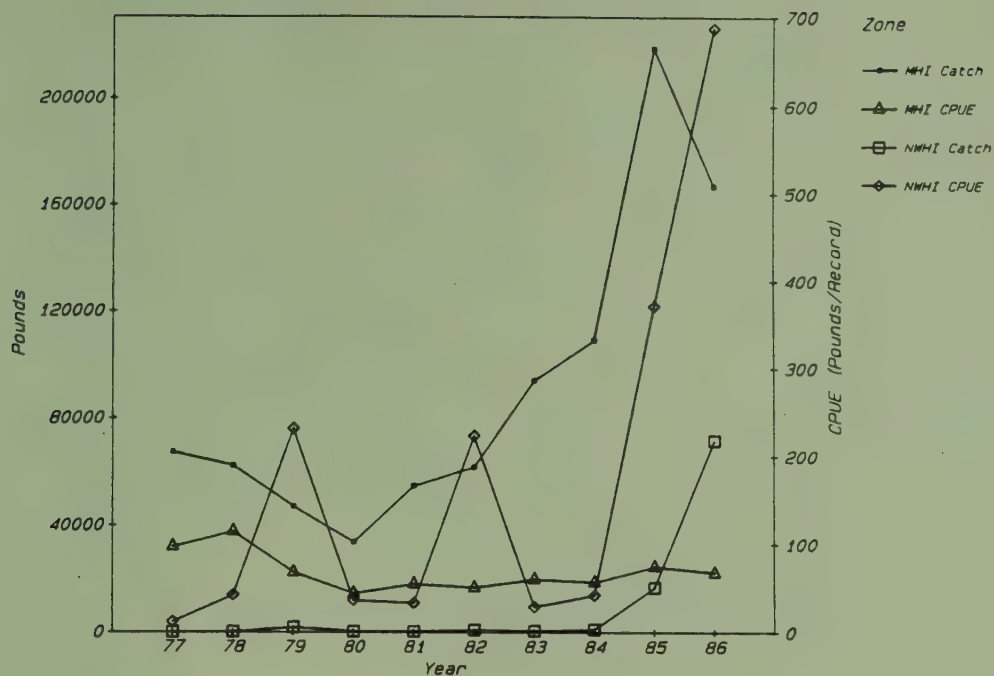


FIGURE 20. ULUA CATCH AND CPUE

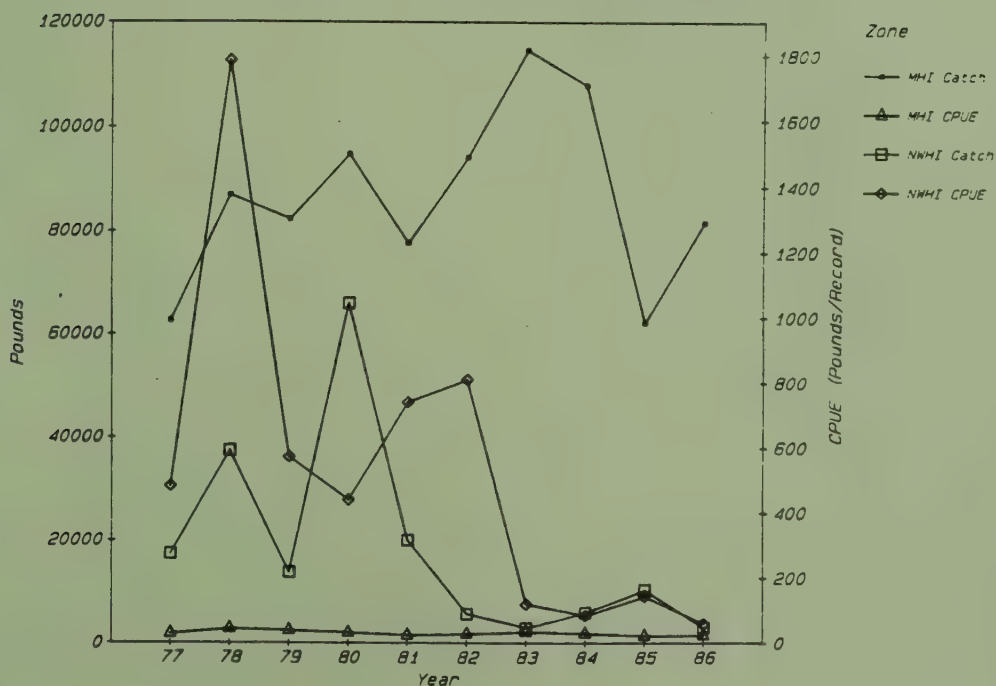


FIGURE 21. LEHI CATCH AND CPUE

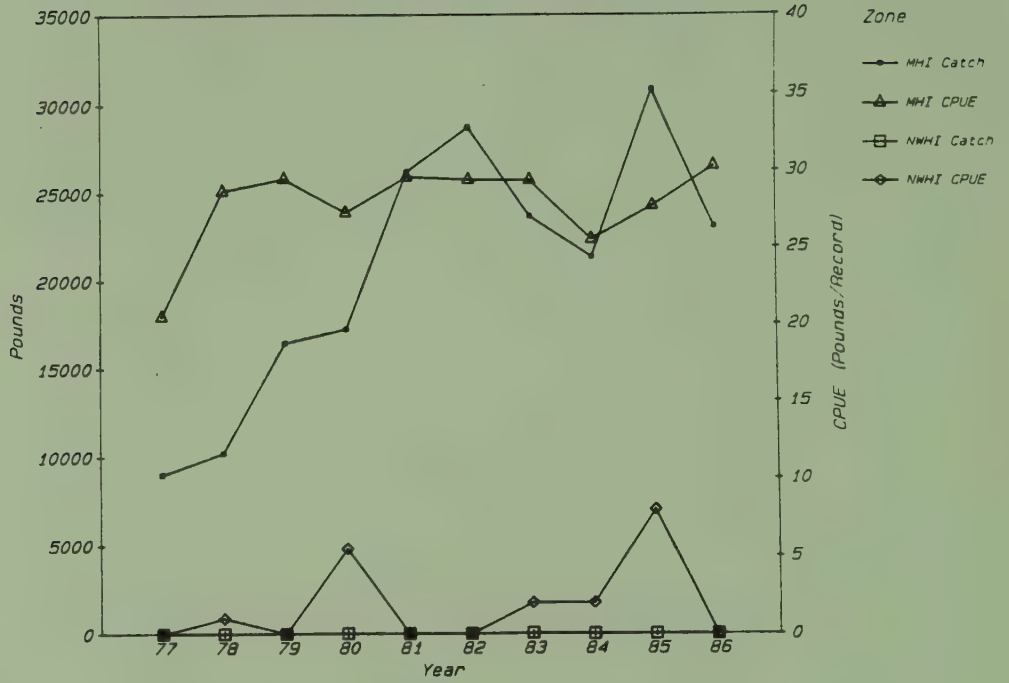


FIGURE 22. GINDAI CATCH AND CPUE

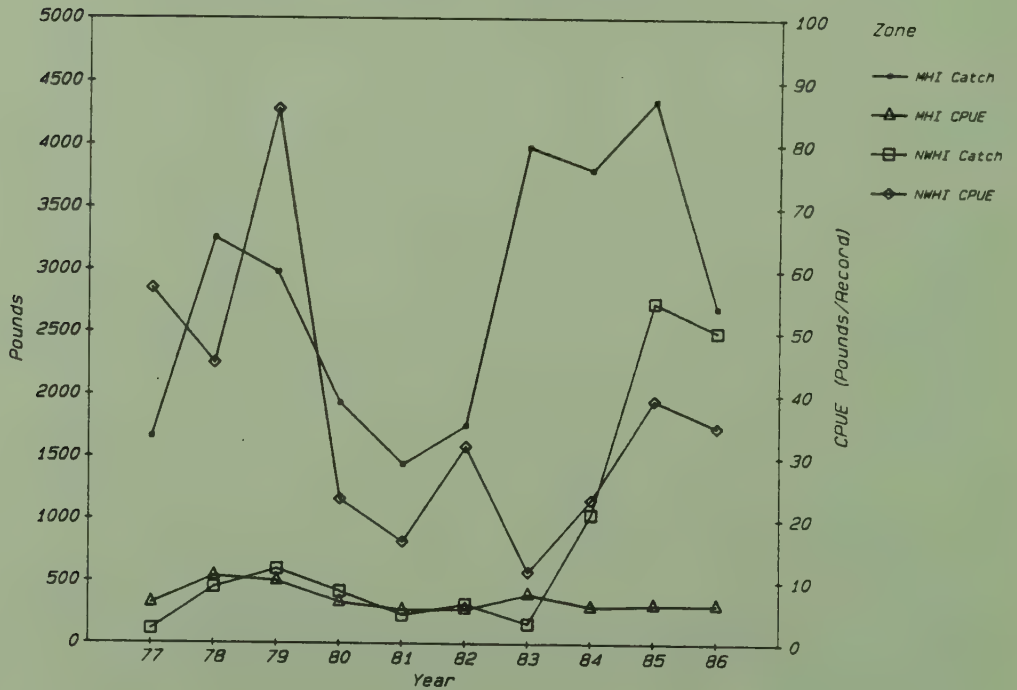


FIGURE 23. TAAPE CATCH AND CPUE

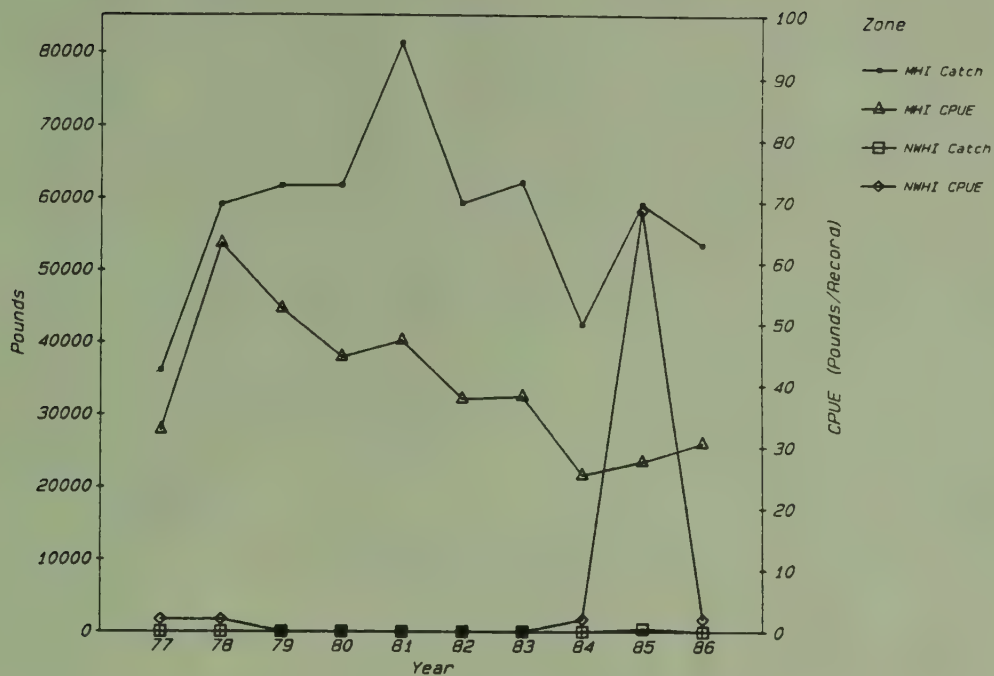


FIGURE 24. BUTAGUCHI CATCH AND CPUE

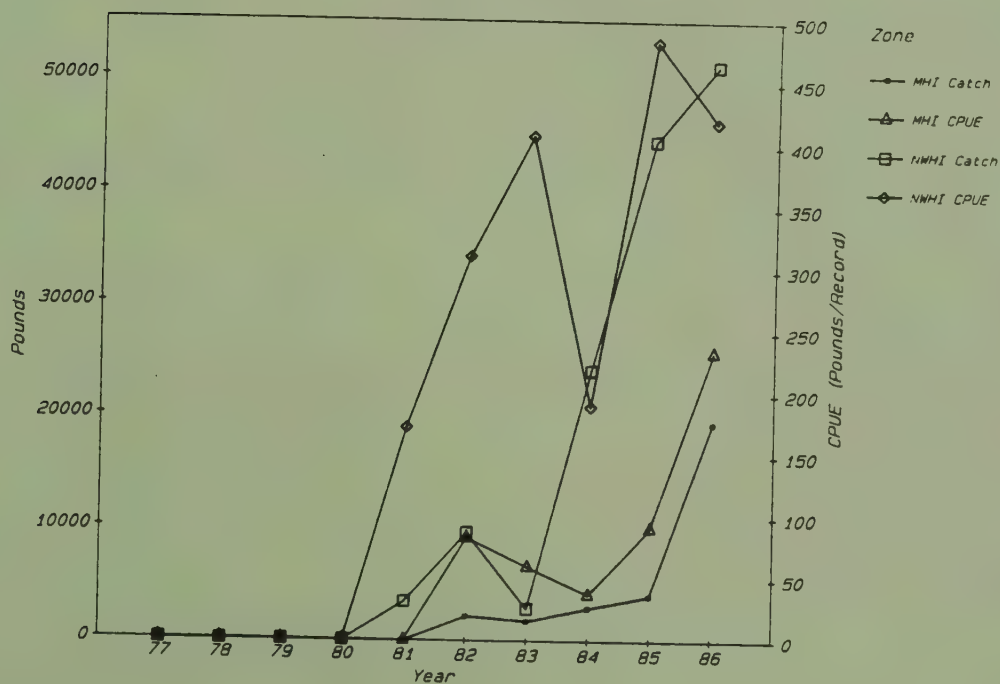
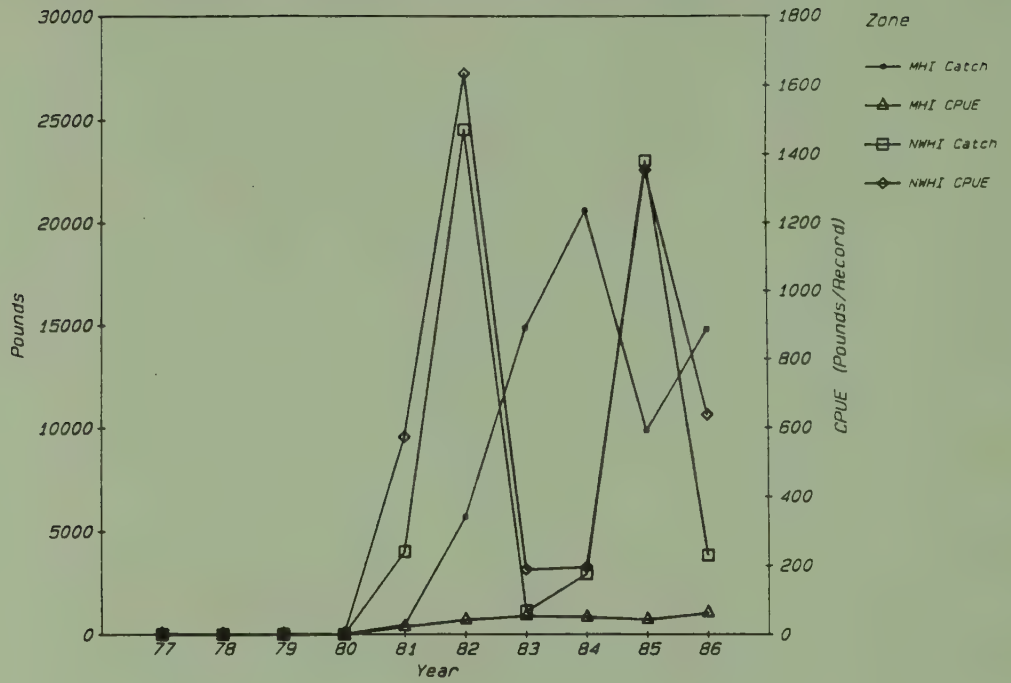


FIGURE 25. WHITE ULUA CATCH AND CPUE





BOTTOMFISH BEING UNLOADED AT THE UNITED FISHING AGENCY,
HONOLULU, HI.

APPENDIX B

AN ECONOMIC DESCRIPTION AND ASSESSMENT
OF THE HAWAIIAN BOTTOMFISHERY IN 1986.

Southwest Fisheries Center Administrative Report H-88-1

ECONOMIC REPORT ON HAWAII'S COMMERCIAL BOTTOM FISHERY, 1986
(Economic Module, Bottom Fish FMP)

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January 1988

INTRODUCTION

This report is the first economic "module" under the Bottom Fish and Seamount Groundfish Fishery Management Plan (FMP) for the western Pacific. The FMP prepared by the Western Pacific Regional Fishery Management Council (Council) (1986) calls for an annual report comprised of a series of independent reports (modules) on aspects of the fishery.

This report describes the recent history of Hawaii's bottom fish fishery, provides preliminary estimates of revenue in Hawaii's bottom fish market for 1986, analyzes fleet dynamics, provides estimates of revenue per vessel for 1986, and proposes a number of research items for the forthcoming year. The report is limited to information on the Hawaii fishery. Information on the bottom fish fisheries of American Samoa, Guam, and the Northern Mariana Islands is contained in a separate module. Information on the biological status of the bottom fish stocks in Hawaii is contained in another module (Ralston and Kawamoto 1987). Ralston and Kawamoto (1987) is also the source of information on species identification.

A project with substantial bearing on this report is the limited entry proposal being prepared by Philip A. Meyer on behalf of the Council (Meyer 1987). Meyer's various reports comprise a pragmatic picture of the bottom fish fishery in the Northwestern Hawaiian Islands (NWHI), and no attempt will be made here to replicate that work.

RECENT HISTORY

The Hawaii deep-sea handline fishery for snappers, groupers, and jacks has grown dramatically over the past 5 yr, with a number of bottom fish species highly valued in restaurant markets. The fishery expanded into the NWHI in the late 1970's, but over half the landings are still from the main Hawaiian Islands (MHI), and fresh bottom fish imported from Pacific island countries is now competing effectively in the Hawaii market.

The number of "active" vessels in the NWHI bottom fishery has grown from 19 in 1984 to 24 in 1986. ("Active vessels" are those vessels taking more than one fishing trip per year.) Although there has been an annual attrition of three vessels per year, new entrants have kept the fleet growing. Through the past 3 yr, a core of 12 vessels has consistently participated in the NWHI fishery.

As the fishing fleet expanded the volume of catch of the six major targeted bottom fish species in the NWHI rose annually, from approximately 500,000 lb¹ (227,000 kg) in 1984 to over 700,000 lb (317,000 kg) in 1986 (as monitored by the Council and the Southwest Fisheries Center Honolulu Laboratory). During 1984-85, most of the vessels were fishing islands that

¹Landings and prices are reported in pounds, which is the industry standard in Hawaii (1 kg = 2.2 lb and 1 metric ton = 2,205 lb).

previously were either unfished or fished very little. By 1986, there were few, if any, unexplored banks, and the economic effect of fishing pressure on the availability of snappers and groupers was clear. Individual fishermen reported exploratory fishing trips in excess of 1,000 nmi in an attempt to find more productive areas, and a number of the core bottom fishing vessels were expected to leave the fishery entirely by the end of 1987.

The increased fishing pressure in 1985 resulted in a decline in the annual catch of opakapaka, the most desired species at that time. Although the decline was not drastic, the fishermen reported that large schools of opakapaka were increasingly hard to locate. During the latter half of 1985, vessels began to focus on onaga, a highly valued but relatively unfished species. The onaga is a deeper dwelling species and commands a price comparable to opakapaka. However, by the end of 1986, onaga catch rates were also declining, and because of shorter shelf life, vessels could not range as far up the NWHI chain and return with a salable product.

HAWAII MARKET

The Hawaii bottom fish market in 1986 was an estimated \$5.3 million, based on wholesale market purchase values (Table 1). Sales from the NWHI bottom fish comprised 37% of the market (\$1.9 million), and from the MHI, 50% (\$2.7 million). Imports from Pacific island areas comprised 13% of total sales (\$700,000).

The average price for bottom fish from the NWHI in 1986 was \$2.23/lb essentially the same as in 1985 (\$2.22/lb) and 1984 (\$2.35/lb) (Table 2). Average price for MHI bottom fish (\$3.24/lb) was 45% higher than that for the NWHI landings in 1986 while the average imported price (\$2.38/lb) was in between these prices (Table 1). These prices do not account for differences in species composition or seasonal distribution.

Preliminary market information for the Hawaii bottom fish fishery in 1986 is presented in Tables 1 and 2 and Figures 1 and 2, and changes in the NWHI market from 1984 to 1986 are depicted in Figures 3 and 4. The data come from market monitoring implemented by the Council in 1984 and taken up by the Honolulu Laboratory in mid-1986. These data are preliminary estimates of revenue because a consistent method for expanding market sampling to the entire market has not yet been developed. Figures in other reports with data on the number of pounds sold differ because of the market-based extrapolation used for these revenue data.

The value of the Hawaii bottom fish fishery is subject to the vicissitudes of the fresh fish market. A consistent complaint by NWHI bottom fish fishermen has been the relatively lower price received for their catch. The major factor affecting these prices, which are substantially higher than most mainland fresh fish prices because of the strong Hawaii market, is the total quantity of bottom fish landed during the week. For vessels taking longer trips into the NWHI, the problems of short-term oversupply and diminished quality can be substantial.

Fishing vessel operators try to control the length and timing of their fishing trips on the expectation that the market will not be depressed by recent landings or by out-of-season demand. Based on an analysis of price response in the Hawaii bottom fish market, the average Hawaii bottom fish prices in 1984 varied only 23% as much as quantity on a weekly basis and 42% on a monthly basis (Pooley 1987). Quality premiums were observed with the higher price for MHI fish, which received up to a 50% price bonus. Price and quantity interrelationships between species groups were observed but were relatively small between the higher valued species, such as opakapaka and onaga.

A parallel statistical investigation was conducted on 1985 Hawaii market data, and the results were essentially the same as for 1984. The weekly price fluctuations are in Figure 5, and the price-quantity relationship is in Figure 6. The coefficient of variation (CV) for market price, defined as the ratio of the standard deviation to the mean, was 30.4% and, for market quantity, was 43.3%. For NWHI bottom fish, the price variation was 39.2%, and the quantity variation was 57.7%. For MHI bottom fish, the price variation was 29.4%, and the quantity variation was 60.0%.

Forty-four percent of the total price variation can be explained by a simple linear regression of weekly bottom fish prices on quantity sold in the Honolulu market from the MHI and NWHI fisheries and a dummy variable representing seasonal factors:

$$\text{Price} = \$3.99 + 0.69 \text{ CD} - 5.2\text{E-}5 \text{ QNWHI} - 3.2\text{E-}5 \text{ QMHI} - 4.6\text{E-}5 \text{ QOTH}$$

$$t\text{-statistic} \left(\begin{array}{cccc} + 2.50* & - 4.05* & - 2.61* & - 1.56 \end{array} \right);$$

where

Price is price per pound of bottom fish (weekly average),
 CD is the consumer dummy variable valued at 1 during peak seasonal buying periods,
 QNWHI is the quantity sold from the NWHI that week,
 QMHI is the quantity sold from the MHI that week,
 QOTH is the quantity sold from other areas that week,
 $R^2 = 0.42$,
 $N = 52$ weeks in 1985,
 Durbin-Watson = 1.41 (data not corrected for serial correlation), and
 * = significant at the 95% confidence level.

Market price and quantity landed from the NWHI were highly correlated ($r = -0.58$), but market price was less closely correlated with MHI landings ($r = -0.30$).

Data for 1986 were not obtained in time to undertake a similar analysis. However, it is clear from the summary data on prices (Table 3) that the price differential between NWHI and MHI bottom fish continues. The Hawaii market in 1986 also obtained a considerable supply of fresh and frozen bottom fish from other Pacific island areas. Their prices were in between MHI and NWHI prices, on average. The 1987 economic module should

be able to update the 1986 and 1987 price response analysis and incorporate consideration of the Pacific island sales.

FLEET DYNAMICS

There were 45 NWHI bottom fish vessels under permit at the end of 1986 (Table 4). The NWHI bottom fishing fleet is composed of a number of types of vessels, many of which have been displaced from other fisheries. These include mainland U.S. shrimp and groundfish trawlers, albacore and salmon trollers, gill-netters, Hawaii tuna longliners, trappers, and mainland U.S. handline vessels. However, because almost half of the permit holders did not participate in the fishery during 1986, the active fleet, as defined earlier, consists of those vessels taking at least one trip during the year.

The active fleet in 1984-86 ranged in length from 12 to 25 m (35 to 76 ft) overall; over 50% of the vessels were in the 18 m (50-60 ft) range. A few motorsailers have been active in the fishery. In 1986, the 24 active vessels made 160 NWHI bottom fishing trips. The number of trips per vessel varied from 1 to 16 trips for individual vessels, average trip length was 15 d, and average fishing time was 6 d.

The fleet also can be categorized into three operational groups: core bottom fish vessels, multifishery vessels, and other vessels (Fig. 7). "Other vessels" are those vessels that have permits but are not active in the NWHI bottom fishery. The 20 core vessels primarily fish for bottom fish throughout the year. The Honolulu-based fleet consists of 15 vessels, and 3 are based on the neighbor islands. Two vessels are semiretired. The vessels in the core group average 17 m (52 ft) long, and only one is over 20 m (60 ft). These vessels took 82.5% of the 160 trips made in 1986 and caught 79% of the bottom fish monitored by the Honolulu Laboratory (Figs. 8, 9).

The 11 multifishery vessels are those whose primary orientation is toward other species, such as albacore, tuna, and lobster. These vessels average 20 m (60 ft) in long. They took 17.5% (28) of the trips and caught 21% of the bottom fish.

The "other" vessels with NWHI bottom fish permits are larger, averaging 24 m (74 ft) long (maximum length) 31 m (94 ft). These are primarily tuna and lobster vessels; none took recorded bottom fishing trips in 1986.

As catch rates declined for prime commercial species, such as opakapaka, search and travel time increased, and loads were mixed with lesser valued species, such as ulua and hapuupuu. Fishing trips that comprised more than one bank became commonplace. Larger vessels with the range to travel farther up the NWHI chain had an advantage over the smaller vessels, which were forced either to spend more time searching in the lower reaches of the archipelago or to increase their fuel capacity by installing additional fuel tanks or carrying 220-L (55-gal) fuel drums on deck.

Fishing effort location was obtained for 60% of the NWHI bottom fish trips recorded by the Council and Honolulu Laboratory monitoring program in 1986. There were 38 trips (40%) taken to the lower NWHI (Middle Bank to French Frigate Shoals) and 57 trips (60%) to the upper NWHI (French Frigate Shoals to Pearl and Hermes Reef).

VESSEL REVENUES

Vessel revenues for 1986 were compiled through the Council and Honolulu Laboratory market monitoring program. These revenues reflect only those trips sampled by our monitoring program. Some trips or some vessels may have been missed. Revenue from species other than bottom fish, on average, comprises 14% of sales. Nonbottom fish revenue is unimportant for most vessels but, for a few vessels, comprises more than half their revenue.

The average vessel in the NWHI sold \$65,300 of bottom fish in 1986. The average trip amounted to \$10,600 of bottom fish. Including the non-bottom fish species, the average vessel in the NWHI sold \$76,700 in 1986 or \$12,500 per trip.

In 1986, seven vessels each took less than three trips, the Council's proposed criterion for participation under its limited entry system. If we omit these vessels and omit trips shortened because of breakdowns, then the remaining vessels sold \$88,100 of bottom fish per vessel in 1986 or \$11,300 per trip (at a rate of 7.8 trips per vessel).

Smaller vessels can make more trips but land less per trip; therefore, it is reasonable to examine vessel revenues by class. We divided the active fleet on which we had complete information into two classes. Class I vessels landed more than \$10,000 of bottom fish per trip, on average, while Class II vessels landed less. Twelve Class I vessels each landed \$14,800 bottom fish per trip or \$120,900 for the year. Eight Class II vessels each landed \$5,400 bottom fish per trip or \$35,900 for the year.

Total revenue for Class I vessels would be \$16,900 per trip (8.2 trips per year), adding 14% of non-bottom fish revenues to the Class I revenues. A Class II vessel's estimated total revenue would be \$6,200 per trip (6.6 trips per year).

Meyer Resources, Inc. (1987) makes projections of economic returns for the average vessel by using values of \$9,800 per trip. His analysis shows the average NWHI bottom fish vessel losing \$9,700 per trip after fixed costs on seven trips per year. Neither Class I nor Class II applies directly to Meyer's analysis, and we cannot adjust his cost figures to estimate costs and net returns per class of vessel. However, we can use the average bottom fishing vessel's returns and apply them to Meyer's cost formula.

The total revenue per trip of the average active bottom fishing vessel was \$11,500 on 7.55 trips in 1986. Applying Meyer's seven-trip formula for costs, the average NWHI bottom fishing vessel made net operating returns (before accounting for fixed costs) of \$2,700 per trip, but lost \$60,000

for the year after fixed (annual) costs (e.g., capital costs, annual repairs, vessel insurance, moorage fees, and administrative costs) (Table 5).

At 1986 catch rates, catch per trip could decline by 30% with fixed crew costs (\$2,356) before the zero (\$0) net operating revenue level would be reached. Of course, this implies much larger total annual losses, at \$80,450 per year, when including fixed costs.

Economic theory suggests that vessel owners will continue to fish as long as operating costs are covered, unless they have a better alternative. In this case, where fixed costs are not covered, on average, by net operating revenues, there is an incentive for a vessel operator to take more trips in an attempt to spread the net operating revenue over fixed costs. This suggests there is still considerable incentive for active bottom fishing vessel owners to continue in the fishery. There is also incentive for other vessels to enter the fishery as long as they can cover their fixed costs in other fisheries or as long as their net operating revenue is lower in other fisheries than, as they perceive, in the NWHI bottom fishery. These factors increase the possibility of economic overfishing in the NWHI and may lead to unfavorable biological effects if the resource is responding to the current levels of fishing effort (Ralston and Kawamoto 1987).

PROPOSED ECONOMIC RESEARCH

The biggest gap in public knowledge about the NWHI bottom fishery concerns the economic condition of the vessels in the fleet. Therefore, a research proposal has been developed between the Honolulu Laboratory and the Council concerning an economic assessment of the NWHI bottom fish fleet. This research will complement the limited entry proposal and provide more exact information on economics of vessel operation. A cost profile of the major classes of bottom fishing vessels will be developed. This cost profile will be used to test the sensitivity of economic conditions to changes in key factors, such as the price of fish and the number of days at sea. This analysis may also be able to integrate existing information on market conditions to examine interactive effects between classes of vessels.

Another priority in economic research concerns the relationship between the Honolulu Laboratory's market sampling and the entire Hawaii market. The last full wholesale market survey in Hawaii was conducted in 1979, and the last full retail market survey was conducted in 1982. Therefore, a new survey of the wholesale and retail market is an important and timely objective. The Honolulu Laboratory will make a proposal for such a survey, although fielding the survey will be contingent upon funding and Office of Management and Budget approval.

SUMMARY

The key features of this report are summarized:

1. Total revenue earned in the NWHI bottom fishery has grown by 35% over the past 3 yr, although price per pound has declined by 5%.
2. Imports from other Pacific islands are now playing an important role in the Hawaii bottom fish market (13%), but their price impact must be analyzed in terms of timing and product composition.
3. Price response to changes in the volume of market sales remains as previously described: flexible but not drastically on a weekly or monthly basis. Premiums for high quality product are substantial.
4. Composition of the bottom fish fleet has been changing rapidly, length of trip is increasing, and more research is required on fleet operations to understand its economic dynamics.
5. Insufficient information is available on fishing costs to reliably estimate the profitability of the entire fleet, or by vessel class. Evidence suggests that, on average, net revenue is being obtained on operations but fixed costs are not being covered. Incentives exist for continued fishing pressure despite an apparently bleak profit picture.
6. Economic research priorities include
 - a) fleet operations analysis,
 - b) vessel cost-earnings information and analysis,
 - c) Hawaii market channels update, and
 - d) economic research on bottom fish fisheries of American Samoa, Guam, and the Northern Mariana Islands.

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Table 1.--Hawaii bottom fish market revenue, 1986.

Source	Revenue ^a (\$)	Average price (\$/lb)
Northwestern Hawaiian Islands	1,900,000	2.23
Main Hawaiian Islands	2,700,000	3.24
	-----	-----
Hawaii subtotal	4,600,000	2.72
	=====	=====
Pacific island nations	700,000	2.38
	-----	-----
Market total	5,300,000	2.67
	=====	=====

^aRevenue is scaled to a market-wide estimate based on the National Marine Fisheries Service and Western Pacific Regional Fishery Management Council monitoring program's sample of Hawaii bottom fish market sales.

Table 2.--Northwestern Hawaiian Islands bottom fish revenues and prices, 1984-86.

Year	Revenue (\$) ^a	Average price (\$/lb)
1984	1,400,000	2.35
1985	1,800,000	2.22
1986	1,900,000	2.23

^aRevenue is scaled to a market-wide estimate based on the Southwest Fisheries Center Honolulu Laboratory and the Western Pacific Regional Fishery Management Council's monitoring program sample.

Table 3.--Hawaii bottom fish prices, 1986.^a

Species	Average price (\$/lb) by source			
	Market	NWHI	MHI	Pacific islands and other sources
Opakapaka	\$3.41	\$3.20	\$3.78	\$3.92
Onaga	3.93	3.13	4.39	3.37
Hapuupuu	1.61	1.56	2.23	3.16
Ulua	1.32	1.07	2.00	1.12
Ehu	2.56	2.14	3.32	2.38
Uku	2.80	2.43	2.86	1.88
Subtotal	\$2.78	\$2.24	\$3.59	\$2.78
Other	1.84	1.62	1.83	1.98
Total	\$2.67 =====	\$2.23 =====	\$3.24 =====	\$2.38 =====

^aData from the Southwest Fisheries Center Honolulu Laboratory market monitoring program.

Table 4.--Northwestern Hawaiian Island bottom fish fleet composition, 1986.

Vessel category	Vessels (No.)	Length (ft)	Trips (No.)	Catch ^a (lb)
Core	20	52	132	623,000
Multifishery	11	60	28	161,000
Other	14	74	0	0
Fleet	45	61	160	784,000

^aAs monitored by the Southwest Fisheries Center Honolulu Laboratory and the Western Pacific Regional Fishery Management Council.

Table 5.--Cost of operation, Northwestern
Hawaiian Islands bottom fishing vessel, 1986.

Operation	Cost ^a
Annual revenue	\$86,825
Operating costs	53,280
Crew share	13,200
Net on operations	\$20,345
Fixed costs	80,450
Net revenue	-\$60,105
	=====

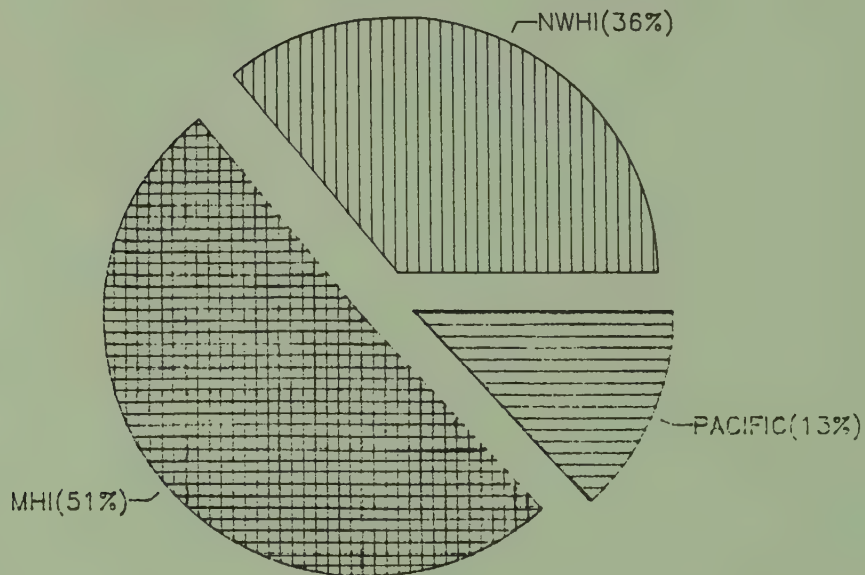
^aCost data estimated from Meyer (1987).

List of Figures

- Figure 1.--Hawaii bottom fish market revenue, by source, 1986.
- Figure 2.--Hawaii bottom fish prices, by source, 1986.
- Figure 3.--Northwestern Hawaiian Island bottom fish revenue, 1984-86.
- Figure 4.--Northwestern Hawaiian Island bottom fish prices, 1984-86.
- Figure 5.--Hawaii bottom fish weekly market price fluctuation, 1985.
- Figure 6.--Hawaii bottom fish market price-quantity relationship, 1985.
- Figure 7.--Categories of Northwestern Hawaiian Island bottom fish vessels, 1986.
- Figure 8.--Trips and landings by vessel category, 1986.
- Figure 9.--Trips and landings by vessel category (percentage), 1986.

HAWAII BOTTOM FISH MARKET 1986

Total Revenue by Source



(\$5.3 million Total)

Figure 1.--Hawaii bottom fish market revenue, by source, 1986.

HAWAII BOTTOM FISH MARKET 1986

Price per Pound

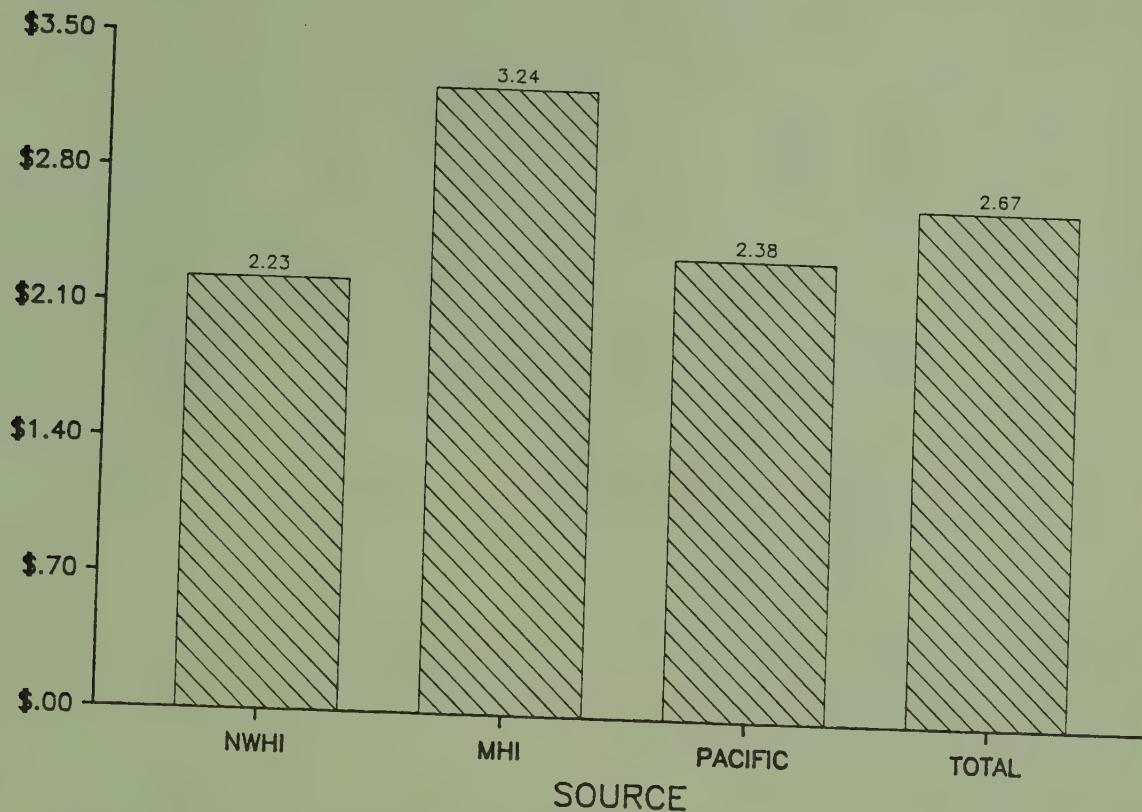


Figure 2.--Hawaii bottom fish prices, by source, 1986.

NWHI BOTTOM FISH REVENUE 1984 - 1986 (\$ Millions)

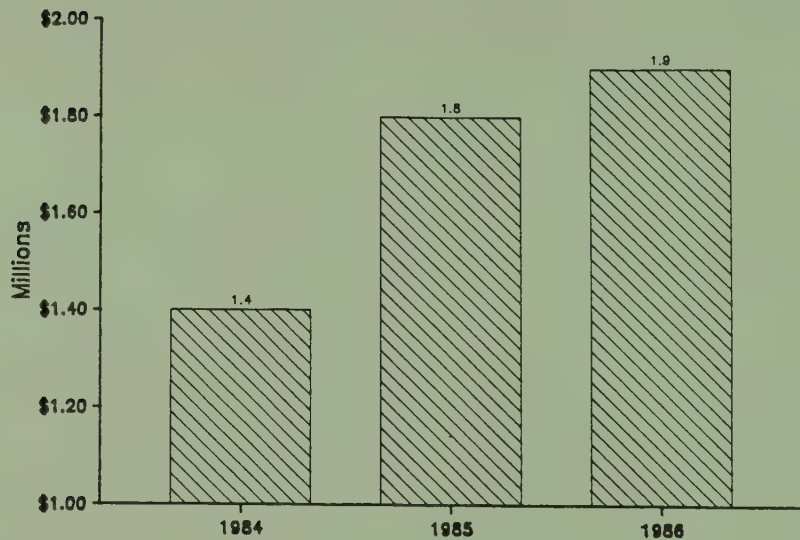


Figure 3.—Northwestern Hawaiian Island bottom fish revenue, 1984-86.

NWHI BOTTOM FISH PRICES 1984 - 1986 (Price per Pound)

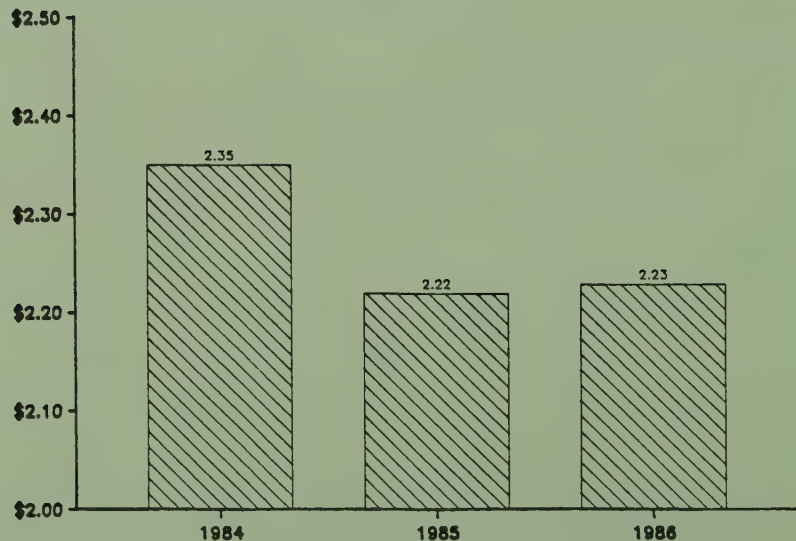


Figure 4.—Northwestern Hawaiian Island bottom fish prices, 1984-86.

Hawaii Bottomfish Prices, 1985

By Week

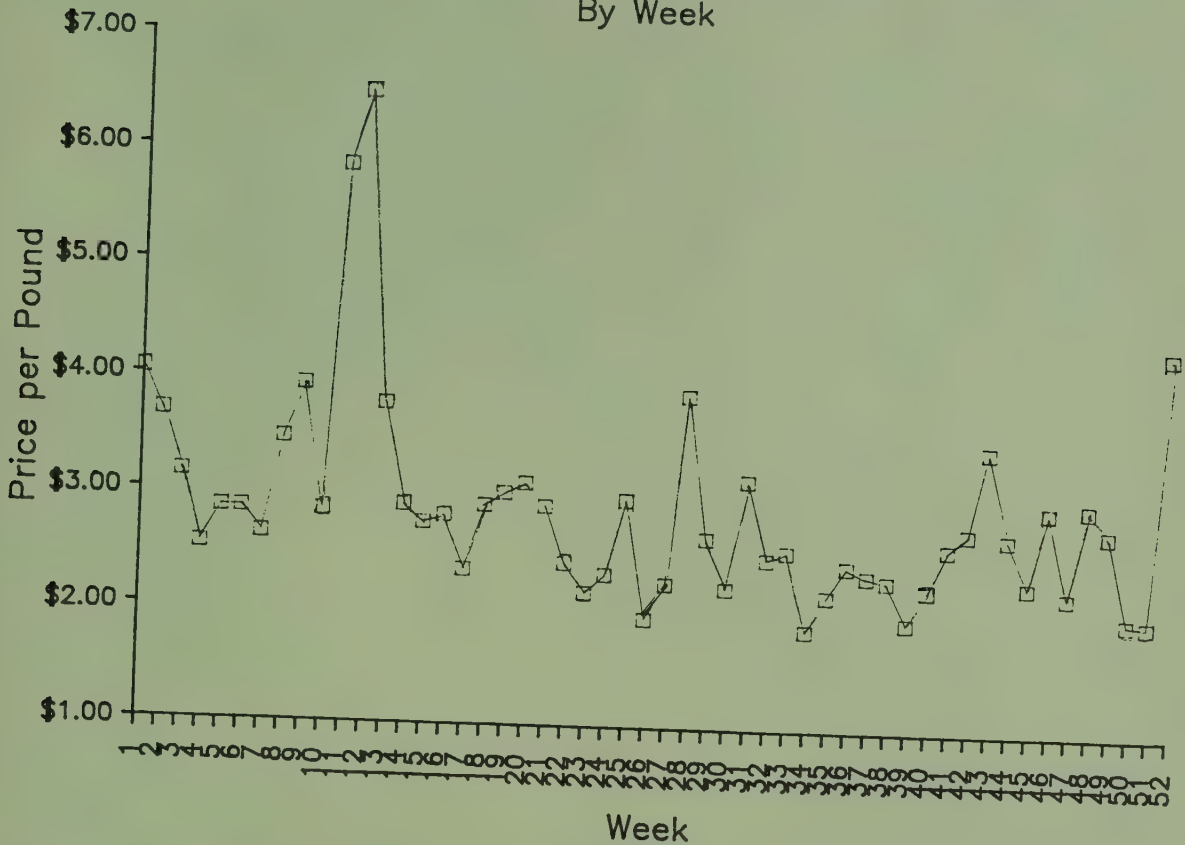


Figure 5.--Hawaii bottom fish weekly market price fluctuation, 1985.

Hawaii Bottomfish Prices, 1985

Price - Quantity Relationship

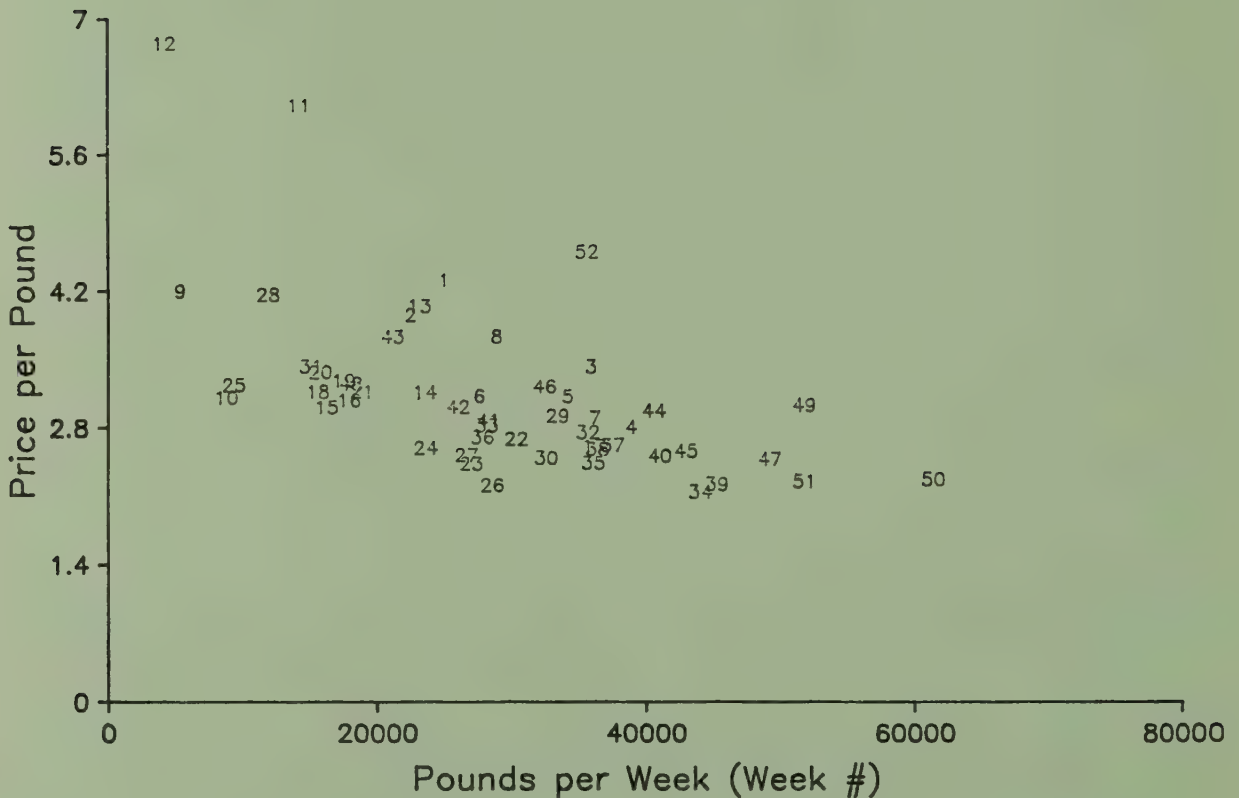
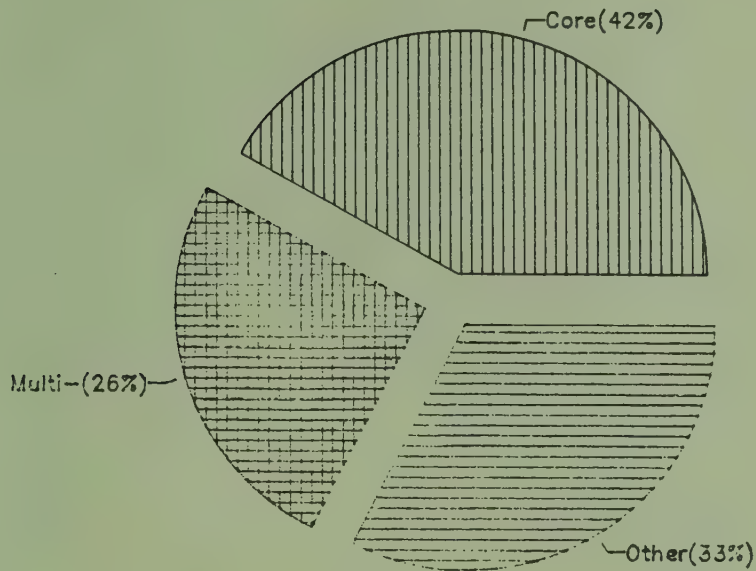


Figure 6.--Hawaii bottom fish market price-quantity relationship, 1985.

NWHI BOTTOM FISH VESSELS 1986

By Category

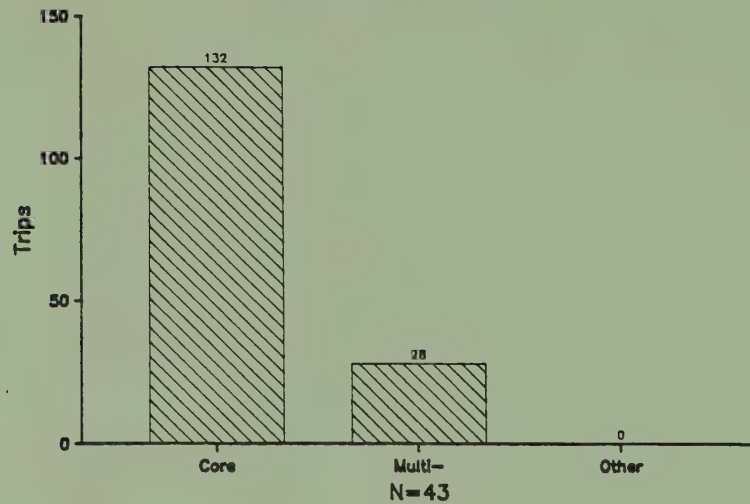


N=43

Figure 7.--Categories of Northwestern Hawaiian Island bottom fish vessels, 1986.

NWHI BOTTOM FISH VESSELS 1986

Trips by Vessel Category



Landings by Category

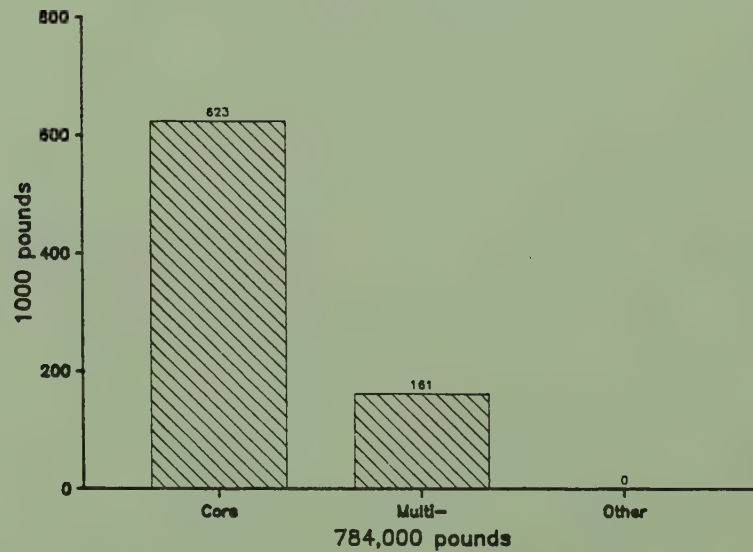
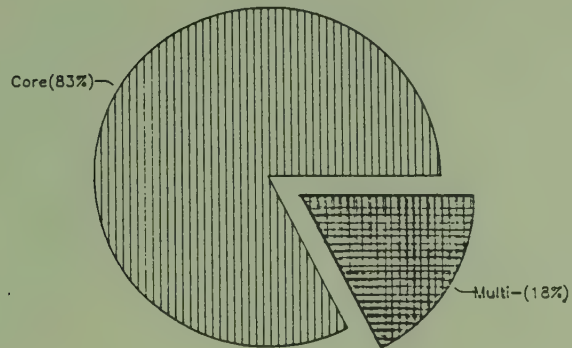


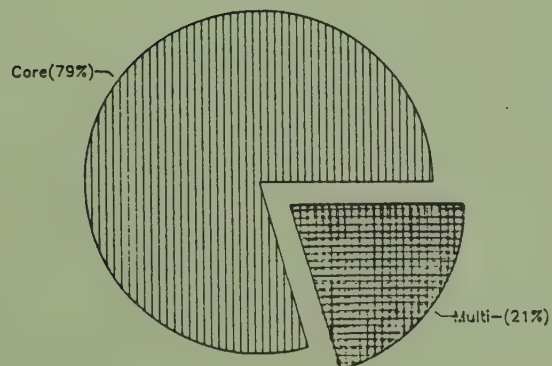
Figure 8.--Trips and landings by vessel category, 1986.

NWHI BOTTOM FISH VESSELS 1986
Trips by Vessel Category



160 Trips

Landings by Category



784,000 pounds

Figure 9.--Trips and landings by vessel category (percentage), 1986.

APPENDIX C

A HL ADMINISTRATIVE REPORT PREPARED
AS A STOCK ASSESSMENT FO THE HAWAIIAN
BOTTOMFISH FISHERY. SIZE-FREQUENCY
ANALYSIS AND OTHER BIOLOGICAL INDICATORS
ARE CONTAINED HEREIN.

Southwest Fisheries Center Administrative Report H-87-7

**AN ASSESSMENT AND DESCRIPTION OF THE STATUS
OF BOTTOM FISH STOCKS IN HAWAII**

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March 1987

ABSTRACT

The Honolulu wholesale market for bottom fish was studied to assess the condition of the fishery and the status of the stocks. Six species comprise the preponderance of landings passing through this market (opakapaka, onaga, ehū, ūku, hapuupuu, and butaguchi) and nearly all lots of bottom fish are of Hawaiian origin (89.6-96.9% between 1984 and 1986).

Total landings indicate the importance of opakapaka to the Hawaiian deep-sea handline fishery, although catches from the Northwestern Hawaiian Islands (NWHI) have declined 16.5% over the last 3 years. A trend of substitution by onaga is increasingly evident in the fishery. Catches of onaga, ehū, hapuupuu, and butaguchi from the NWHI have all increased substantially from 1984 to 1986. In contrast, bottom fish landings from the main Hawaiian Islands (MHI) have remained very stable (coefficient of variation = 3.0%).

Size structured yield-per-recruit analyses demonstrate that the MHI fisheries for opakapaka, ehū, and ūku are moderately to severely growth-overfished. These species may benefit from minimum size restrictions. In contrast, an increased harvest of onaga in the MHI is suggested while the fishery for hapuupuu is close to optimal.

In the NWHI there is no evidence of growth-overfishing for any of the five species analyzed (opakapaka, onaga, ehū, hapuupuu, and butaguchi). This is likely due to the fishery being in a state of disequilibrium, the result of increasing fishing effort (30% increase in 3 years) and major changes in fishing grounds. In 1986 the fishery for bottom fish in the NWHI shifted almost 300 nmi to the northwest as more distant stocks were more heavily exploited.

Current harvest levels in the MHI are believed near maximum sustainable yield, although much better information concerning the recreational and unaccounted for commercial catch of these fishes is necessary before a more accurate assessment can be made. In the NWHI landings are presently in excess of the best available estimate of MSY as bottom fish stocks are "fished up." It is recommended that better data on the location of bottom fish harvests in the NWHI be obtained for future assessment work.

INTRODUCTION

As used by the fishermen of Hawaii and other island locations in the tropical Pacific, the term bottom fish refers to the complex of species typically caught with deep-sea handline gear. Most are snappers (lutjanids) and related forms (i.e., lethrins and emmelichthyids), although groupers (epinepheline serranids), several species of jacks (carangids), and at least one scorpionfish (scorpaenid) are included in the fish community that is harvested by hook-and-line fishing gear in offshore waters 60-300 m deep. Bottom fish are usually found in habitats characterized by hard bottom of high structural complexity, restricting their accessibility to trawl and longline gears. Historically the Hawaiian deep-sea handline fishery for bottom fish has been one of the most important in the State, serving both commercial and recreational sectors of the community. A number of previous workers have studied and described aspects of the biology (Ralston and Polovina 1982; Ralston and Miyamoto 1983; Ralston 1984; Ralston, Gooding, and Ludwig 1986; Polovina 1987) and economics (Hau 1984; Pooley 1987) of this fishery (see also Hawaii Department of Land and Natural Resources 1979; Ralston 1979, 1982).

In 1986 a fishery management plan (FMP) was implemented by the Western Pacific Regional Fishery Management Council (Council) for the bottom fish and seamount groundfish fisheries of the western Pacific region (Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands). The plan was prepared under the guidelines of the Magnuson Fishery Conservation and Management Act of 1976 and is intended to result in the management of the bottom fish fishery so that optimal yields are realized.

The bottom fish FMP stipulates that every year a monitoring team appointed by the Council will assess the biological and economic conditions prevailing in the fishery and will prepare a report that presents its findings to the Council. If deemed necessary the team will suggest alternatives for corrective management action. The work presented here, by examining a variety of biological factors and fishery performance indicators that have been gleaned from a market sampling program, represents a biological contribution to the monitoring team's annual assessment of the fishery. Particular attention is paid to the size structure of certain key species in the Hawaiian fishery. This specific type of analysis has been used previously (Ralston and Kawamoto 1985) and is described in detail elsewhere (Ralston, Tagami, and Shiota 1986).

METHODS

The data used here were derived from a sampling program designed to monitor the landings of commercial fishermen at the centralized wholesale fish market in Honolulu. The fish passing through these market channels are a subset of the entire Statewide commercial bottom fish catch. Significant markets also exist on Maui, Hawaii, and Kauai. Moreover, there is without doubt a substantial recreational-subsistence harvest of bottom fish. The catch totals compiled here, therefore, do not represent meaningful absolute statistics. The value of monitoring the catch at this wholesale

level is that it represents the most centralized point at which a large volume of landings can be intercepted and data economically collected. Because such a large share of the total Statewide catch of bottom fish is marketed there, trends and patterns in the data collected at the wholesale market are believed to be indicative of the fishery as a whole.

At the wholesale market bottom fish are auctioned either as individual fish or more commonly in lots. A lot is composed of a grouping of conspecific fish from a single fisherman's landings on a given day. Significantly, fish are sorted by size before assignment to lots, so that all those within a single lot tend to be of similar size (Ralston, Tagami, and Shiota 1986). For each lot of fish sold at the market it is possible to record the following information: (1) the species, (2) the total weight (1b) of the lot, (3) the number of individual fish comprising it, (4) the fishing vessel landing the catch, (5) the general location of fishing, (6) the purchaser, (7) the bid price, and (8) the date of the transaction. Previous work has shown that one can recover 88.0-99.3% of the information regarding actual bottom fish size structure by examination of these simple lot statistics (Ralston, Tagami, and Shiota 1986). Thus, size-frequency analysis of these data is possible.

The above data were recorded for all lots of bottom fish sold over the 3 years spanning 1984-86. The data were entered into a computer file in which each lot of fish comprises one record (observation) composed of the eight variables listed above. Various summary statistics were computed using Statistical Analysis System computer routines (SAS 1985a, 1985b, 1985c).

Weight-frequency distributions were compiled and analyzed in detail to estimate various biological and fishery dependent parameters. For each distribution considered the ascending portion of the curve (including the modal size class) was used to determine the weight at entry to the fishery (w_c) as suggested by Gulland (1969). Species were assumed fully vulnerable to the gear in all weight categories greater than, but not equal to, the mode. The descending portion of each weight-frequency distribution (excluding the mode) was transformed to a length-frequency polygon using the length-weight regressions provided in Loubens (1980), Uchiyama et al. (1983), Brouard and Grandperrin (1984), and Ralston (in press). In all cases analyzed the descending portions of catch length-frequency distributions were assumed to accurately depict stock size structure. This is equivalent to assuming constant selectivity of the gear (hooks) over the full size range of the descending limb, i.e., a "trawl" type sigmoidal selection curve. It is noteworthy that evidence exists in support of this assumption (Ralston 1982; Ralston unpublished data), although it is undoubtedly a simplification of what is in reality a complex interaction between the fish and the fishing gear.

The descending limbs of length-frequency distributions, pooled over 1984-86, were used to estimate the maximum length parameter (L_∞) of the von Bertalanffy growth model using the regression method of Wetherall et al. (in press). The data were pooled due to the instability of L_∞ estimates calculated for each year separately. The growth coefficient (K) of the von

Bertalanffy model was estimated from L_{∞} using the growth performance equation derived specifically for snappers and groupers by Manooch (1987). This in turn was used to estimate the natural mortality rate (M) as suggested by Ralston (1987) in his study of snapper and grouper mortality rates. Total mortality rates (Z) were estimated from the descending limbs of length-frequency distributions using both the Beverton and Holt (1956) length-based estimator and the length converted catch curve method of Pauly (1982). In general there were no systematic differences between the two estimates of Z (Fig. 1), so they were averaged to produce a final estimate of Z . Instantaneous fishing mortality rates (F) were determined by subtraction ($F = Z - M$) and ages at entry to the fishery (t_c) were calculated from w_c , the length-weight regression, and the estimates of von Bertalanffy growth parameters. Maximum weight parameters (W_{∞}) were estimated with the values of L_{∞} and the appropriate length-weight regression.

Yield-per-recruit analyses were conducted using the various parameters estimated from size structure (W_{∞} , K , M , F , and t_c). All species were assumed to recruit to the fishery at age 1 (i.e., constant natural mortality rate thereafter) and the simplified cubic form of the equilibrium Beverton and Holt (1957) yield equation based on isometric growth was used in lieu of the more complicated computations involving the incomplete beta function (Wilimovsky and Wicklund 1963). Previous calculations by Ralston (1981) using the latter had failed to appreciably alter the analytical result for opakapaka, Pristipomoides filamentosus. As suggested by Ricker (1975) the upper bound of the yield equation integral was assumed infinite.

In addition to total landings and size structure, another useful application of the wholesale market data set is the calculation of fishing effort and catch per unit effort (CPUE) statistics for the Northwestern Hawaiian Islands (NWHI) fishery. All bottom fishing trips to the NWHI tend to be of relatively short duration (approximately 2 weeks) because the product is marketed fresh at the wholesale market. For the same reason, when brought to port a vessel's landings are quickly sold. On the other hand the distance to the fishing grounds requires a minimum of 4 days transit time. Thus, it is possible to determine the number of fishing trips to the NWHI each year by following the pattern of sales at the market by individual fishermen. While on occasion it may require as much as 4 days to completely offload and sell the catch obtained from any particular trip to the NWHI, if 5 consecutive business days elapse at the wholesale market in which no subsequent transactions relating to that vessel occur, the sales from that trip can be considered complete. The total trip landings can then be determined by summation and, by examining the sales by all fishermen at the wholesale market, the total number of bottom fishing trips to the NWHI can be calculated for any given time period.

RESULTS

The data were first summarized to determine what species of bottom fish appear in the wholesale market samples. The results given in Table 1 show that many species are sold at the market, although a small subset accounts for the preponderance of lots. In particular, seven species (opakapaka,

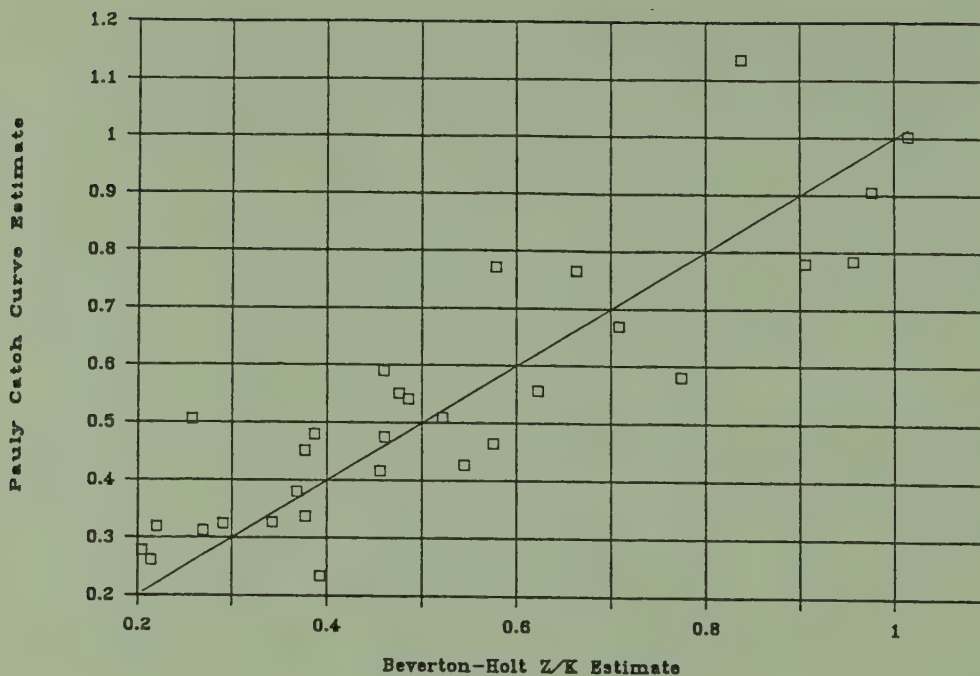


Figure 1.--A comparison of total mortality rate estimates (Z) derived from the Beverton and Holt (1956) length-based estimator and the Pauly (1982) length converted catch curve. The solid line represents equality of the estimates (units are per year).

Table 1.--Bottom fish species sold at the wholesale market from 1984 to 1986. The figures represent the percentage each species contributed to the total number of bottom fish lots in a year. A dash indicates trace quantities. Note that this table contains fish from areas other than Hawaii.

Family Species	Common name	1984	1985	1986
Lutjanidae				
<u>Pristipomoides zonatus</u>	Gindai	2.0	2.6	2.2
<u>P. filamentosus</u>	Opakapaka	28.8	20.0	18.8
<u>P. sieboldii</u>	Kalekale	3.8	5.3	3.9
<u>P. flavipinnis</u>	Yelloweye opakapaka	0.2	0.2	0.3
<u>P. auricilla</u>	Yellowtail kalekale	0.2	0.5	0.2
<u>P. multidentis</u>	Goldbanded jobfish	0.1	0.4	0.4
<u>P. argyrogrammicus</u>	Ornate jobfish	--	--	--
<u>P. typus</u>	Sharptooth jobfish	--	--	--
<u>Etelis cornuscans</u>	Onaga	14.7	21.4	21.2
<u>E. carbunculus</u>	Ehu	8.7	15.2	15.1
<u>Lutjanus kasmira</u>	Taape	2.8	3.5	2.4
<u>L. fulvus</u>	Toau	0.9	0.6	0.8
<u>Aphareus rutilans</u>	Lehi	1.9	2.9	1.6
<u>A. furca</u>	Hanui	0.3	0.2	--
<u>Aprion virescens</u>	Uku	9.1	2.6	4.6
<u>Paracaesio</u> spp.	Various	--	0.2	0.4
--	"Snapper"	--	0.2	--
Emmelichthyidae				
<u>Erythrocles schlegelii</u>	Golden kalekale	0.2	0.2	0.2
Serranidae				
<u>Epinephelus quernus</u>	Hapuupuu	9.0	8.2	8.6
<u>Epinephelus</u> spp.	Various	0.3	0.4	0.5
Carangidae				
<u>Psuedocaranx dentex</u>	Butaguchi, pig ulua	4.9	5.4	5.9
<u>Caranx ignobilis</u>	White ulua	3.7	3.8	2.6
<u>Caranx</u> and <u>Carangoides</u> spp.	Ulua	7.2	4.5	8.1
<u>Seriola</u> spp.	Kahala	--	0.1	0.2
Scorpaenidae				
<u>Pontinus macrocephalus</u>	Hogo	1.1	1.5	1.6

onaga, ehu, uku, hapuupuu, butaguchi, and ulua) comprised 77.3-82.4% of all bottom fish lots sold from 1984 to 1986. The total numbers of bottom fish lots recorded during these years were 22,461, 34,612, and 39,840, respectively.

Fishing areas for the bottom fish sold at the wholesale market from 1984 to 1986 are presented in Table 2. In this table all areas are mutually exclusive categories, i.e., if a lot appears under the Twin Banks heading it does not appear under either the NWHI or Hawaiian Islands headings. Examination of the data in the table shows that out of State sales of fish are assuming increasing importance. Whereas in the past only American Samoa and Fiji shipped bottom fish to the wholesale market on a regular basis, in 1986 a wide variety of Pacific island nations marketed bottom fish in Honolulu. Nonetheless, bottom fish caught in Hawaii represent the vast majority of the market sampling data. In the first year of sampling 96.9% of all bottom fish lots were composed of fish caught in Hawaii. For the subsequent 2 years the figures are 93.9 and 89.6%.

A significant development in the collection of the location data is that the precision of the information has steadily improved. Since 1984, both the fraction and number of bottom fish lots classified to the "Hawaiian Islands" area category declined to zero. In 1986 it was possible to assign all Hawaiian bottom fish landings to either the main Hawaiian Islands (MHI) or the NWHI categories. Likewise, within the NWHI region, only 15% of the lots sampled in 1984 had the specific bank of harvest recorded. In 1986 the situation was reversed; 64% of all NWHI bottom fish lots were classified to specific bank or island locations. In spite of the marked improvement in the collection of the 1986 data, the fairly crude geographical resolution that characterizes the first 2 years of data precludes detailed treatment on a bank by bank basis. For this reason, the fundamental separation of MHI and NWHI landings was the only areal distinction made in the yield analyses that follow.

Moreover, due to the abundance of lot statistics for opakapaka, onaga, ehu, uku, hapuupuu, and butaguchi, and the relative paucity of data concerning the remaining species, detailed analyses were conducted only on this subset of species. Note that although "ulua" accounts for a substantial number of lots (4.5-8.1%), it is a heterogeneous group of species, each of uncertain taxonomic affiliation.

Landings of Hawaiian Bottom Fish at the Wholesale Market

The data presented in Table 3 summarize the total Hawaiian landings of opakapaka, onaga, ehu, uku, hapuupuu, butaguchi, and total bottom fish. The figures given represent only the catch that is known to have been caught in either the MHI or the NWHI. However, the remaining "Hawaiian Islands" catch (see Table 2) amounts to no more than 3.4% of these totals. In aggregate this catch represents 82.4-86.9% of all the bottom fish sold at the wholesale market from 1984 to 1986, regardless of species or area caught.

Table 2.--Harvest locations of bottom fish appearing at the wholesale market during 1984-86. The figures represent the percentage each area contributed to the total number of bottom fish lots in a year. A dash indicates trace quantities and a zero no recorded landings. All area categories are treated as mutually exclusive.

Area	1984	1985	1986
Hawaiian Islands	2.4	1.3	0
Main Hawaiian Islands	3.7	2.2	0.4
Hawaii	10.0	18.0	12.3
Maui	0.5	--	0.2
Molokai	1.6	2.7	3.1
Oahu	37.0	31.1	37.0
Kauai	7.1	6.1	2.3
Northwestern Hawaiian Islands	29.5	29.7	12.3
Middle Bank	0.1	0	0.6
Nihoa	--	0.1	0.8
Twin Banks	0	0.9	0.3
Necker Island	0.6	0.3	1.3
French Frigate Shoals	1.0	0.3	0.9
Brooks Banks	2.6	0	0.5
Gardner Pinnacles	0.4	0	2.4
Raita Bank	0	0	1.5
Maro Reef	0	0	0.7
Laysan Island	0.4	0.1	1.4
Northampton Seamounts	0	0	0.8
Pioneer Bank	0	0.2	1.0
Lisianski Island	0	0	9.0
Pearl and Hermes Reef	0	0	0.6
Line Islands	0	0	0.1
Tahiti	0	--	0
American Samoa	2.1	0.6	1.2
Western Samoa	0	0	--
Tonga	0	--	0.1
Fiji	0.9	3.3	6.8
Vannatu	0	--	0.1
Federated States of Micronesia	0	0	0.1
Pohnpei	0	0	--
Yap	0	0	--
New Zealand	0	0	0.2
Australia	0	0	1.5
Palau	0	2.1	0.1
Guam	0	0.1	0.1
Taiwan	0	0	0.1

Table 3.--Total landings (in metric tons) of Hawaiian bottom fish from the main Hawaiian Islands and the Northwestern Hawaiian Islands.

	1984	1985	1986
<u>Opakapaka</u>			
Main Hawaiian Islands	37.5	30.9	34.2
Northwestern Hawaiian Islands	143.4	140.5	119.8
<u>Onaga</u>			
Main Hawaiian Islands	36.7	64.4	56.2
Northwestern Hawaiian Islands	3.1	23.4	43.1
<u>Ehu</u>			
Main Hawaiian Islands	6.5	12.9	11.6
Northwestern Hawaiian Islands	2.2	9.3	11.8
<u>Uku</u>			
Main Hawaiian Islands	31.1	8.1	20.1
Northwestern Hawaiian Islands	3.4	0.7	3.0
<u>Hapupu</u>			
Main Hawaiian Islands	6.7	3.4	3.4
Northwestern Hawaiian Islands	46.1	66.5	84.3
<u>Butaguchi</u>			
Main Hawaiian Islands	0.8	0.4	0.6
Northwestern Hawaiian Islands	29.5	56.2	63.5
<u>All six species</u>			
Main Hawaiian Islands	119.4	120.1	126.0
Northwestern Hawaiian Islands	227.7	296.5	325.5

It is apparent from these results that opakapaka has been the mainstay of the bottom fish fishery in Hawaii, especially if only the NWHI is considered. For example, this species alone comprised over half the Hawaiian bottom fish share of the wholesale market in 1984. However, there has been a marked (16.5%) decline in the harvest of this species in the NWHI over the period in question. In contrast, landings from the MHI appear to be relatively stable.

Onaga is the second most important species in the Hawaiian deep-sea handline fishery, contributing 22.0% to the 1986 total. In contrast to opakapaka, the catch of this species has generally risen from 1984 to 1986, most notably in the NWHI where landings increased fourteenfold in 3 years. Moreover, in the last 3 years the onaga catch from the MHI has generally exceeded opakapaka landings from the same area.

From 1984 to 1986 the catch of ehu from the NWHI increased markedly, likely in direct association with the increase in onaga landings. Both species inhabit deeper habitats than opakapaka and, for that reason, they tend to co-occur in the catch (Ralston and Polovina 1982).

As measured by the coefficient of variation (CV), landings of uku from the MHI are highly variable (CV = 58%). The fishery for this species is very seasonal during the early summer months (Ralston 1979), a time when uku aggregate to spawn. Because no other Hawaiian bottom fish is known to similarly aggregate, this aspect of the life history may be related in some way to the relatively high variation in catch between years. Moreover, it is evident from the data in Table 3 that compared with the MHI, the NWHI harvest of uku is presently negligible. Insufficient numbers of uku were recorded from the NWHI region to perform a size structured analysis of yield per recruit, although a number of fishermen have displayed an increasing interest in the Middle Bank and Necker Island stocks of uku.

Like the onaga and ehu, landings of hapuupuu from the NWHI have increased dramatically in recent years (83%). While substantially less than the NWHI, the MHI catch is nonetheless of sufficient magnitude to allow a yield analysis. The data suggest that the MHI hapuupuu catch may be waning. Overall the hapuupuu is the third most important species of bottom fish in the Hawaiian fishery on the basis of landed weight, trailing opakapaka and onaga.

The geographical distribution of butaguchi is limited almost entirely to the NWHI, where almost 99% of all landings are taken. This pattern is reciprocal to that of the uku. Consequently, insufficient quantities of butaguchi were landed from the MHI to analyze further. In parallel with onaga, hapuupuu, and ehu, landings of butaguchi from the NWHI show a steady increase from 1984 to 1986, rising 115% during this time.

The general pattern of the wholesale market landings of these six species taken together shows a distinct difference between the trends in the MHI and NWHI regions. In aggregate, over the 3-year span for which there are data, the MHI catch has been very stable (CV = 3.0%) while the NWHI catch has increased 43.0%.

It is also of considerable interest to compare the wholesale market landings of bottom fish from the MHI and the NWHI with our current estimates of the maximum sustainable yield (MSY) from these areas. In a memorandum to the members of the Bottom Fish Planning Team dated 27 March 1986, Stephen Ralston of the National Marine Fisheries Service, Southwest Fisheries Center Honolulu Laboratory summarized information pertaining to estimates of bottom fish productivity (Ralston and Polovina 1982; Polovina 1984; Polovina and Ralston 1986) and habitat area within the Hawaiian Islands. Bottom fish MSY for the MHI was estimated to be 285 t, while for the primary fresh access zone of the NWHI (Nihoa to Lisianski Island) it was set at 275 t. The data presented in Table 3 show that over the last 3 years the MHI "wholesale market" harvest level has been stable at a value somewhat less than our best estimate of MSY. In fact, these data indicate that only 43% of the potential MHI yield is being caught and marketed at

the wholesale level. By comparison the 1986 NWHI catch of bottom fish sold at the wholesale market is substantially in excess of the projected MSY (18% greater).

Size Structured Analysis

In this section the size structure of six different species (opaka-paka, onaga, ehu, uku, hapunpuu, and butaguchi) will be considered in some detail. Moreover, the wholesale market landings of these fishes have been separated into MHI and NWHI categories. As previously indicated, the NWHI catch of uku and the MHI catch of butaguchi were insufficient to perform yield-per-recruit analyses. This leaves 10 different species by area combinations to examine.

Main Hawaiian Islands Opakapaka

Weight-frequency histograms for the 1984-86 catch of MHI opakapaka are presented in panels A-C of Figure 2. Note that the presence of individuals in the "0" pound weight class (e.g., for 1984 and 1986) indicates the existence of some illegal fish weighing 0.00-0.50 lb. This is because all weights were rounded to the nearest integer. Note also that the modal size of MHI opakapaka dropped from 1.36 kg (3 lb) in 1984 to 0.91 kg (2 lb) in 1985 and 1986.

Panel D of Figure 2 provides the relative length structure of MHI opakapaka during the time period in question. These data, jointly and in isolation, were used to estimate the following parameters: L_{∞} , W_{∞} , Z , w_c , and t_c (Table 4). It was then possible to perform a yield-per-recruit analysis (Fig. 3), the results of which indicate that over the 1984-86 period the age at entry to the fishery (t_c) has dropped substantially as fishing mortality rate has increased. If the current trend continues yield per recruit will decline. Ralston and Kawamoto (1985) believed the 1984 value of t_c to be slightly less than 2.0 years, while that given here is approximately 3.0. The difference in estimates is due to the more limited data available to the former study (1,347 MHI opakapaka sampled in the 6 weeks from mid-January to the end of February). In any event, the primary conclusion at this point is that the age at entry is presently too low.

Northwestern Hawaiian Islands Opakapaka

Similar data are presented in Table 4 and Figures 4 and 5 for the NWHI "stock" of opakapaka. The histograms show that NWHI opakapaka are generally much larger than their MHI counterparts. Relatively speaking, very few small fish are landed from the NWHI, i.e., t_c is quite high. Neither is there evidence of growth overfishing due to excessive fishing effort. Moreover, the current trend appears to indicate a lessening of fishing mortality and an increase in the age at entry. This result is likely due to relatively unexploited fishing grounds being targeted in 1985 and 1986, with the catch demonstrating a virgin size structure (see section on

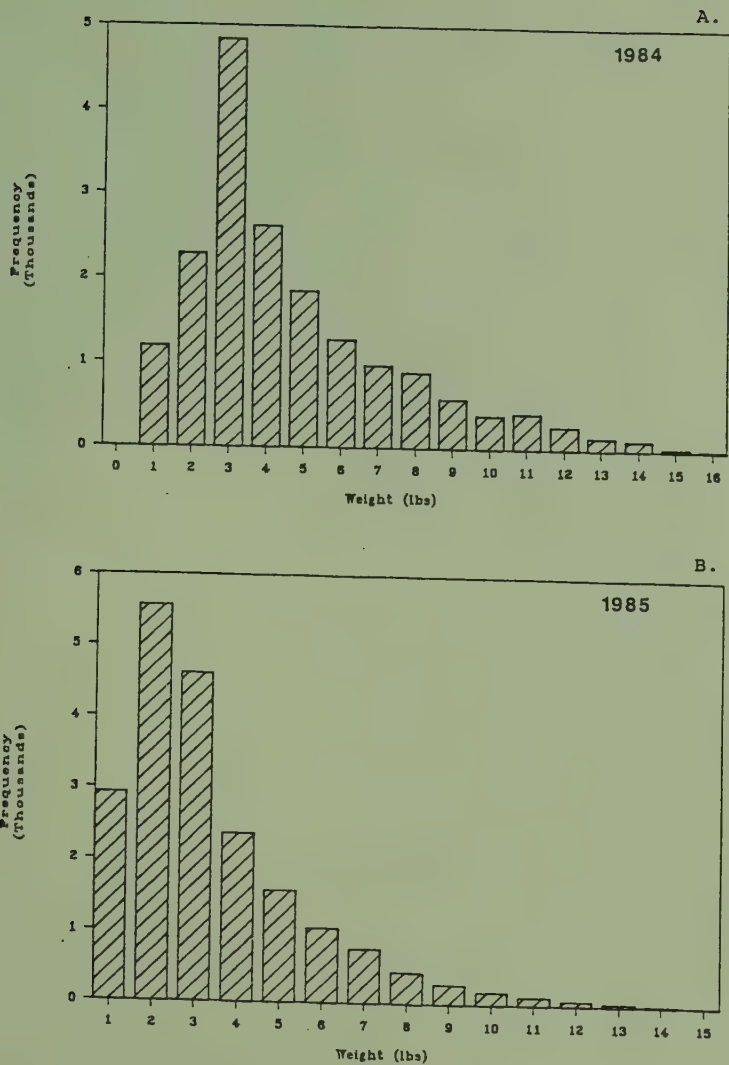


Figure 2.--Size structure of opakapaka landed from the main Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

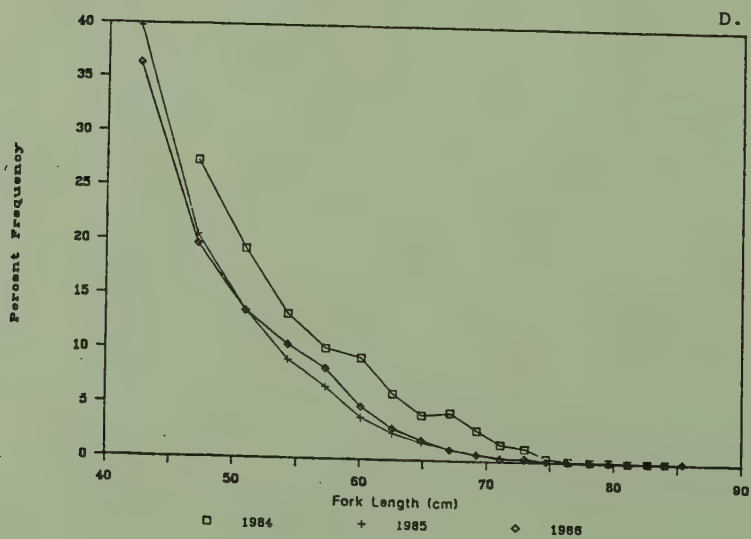
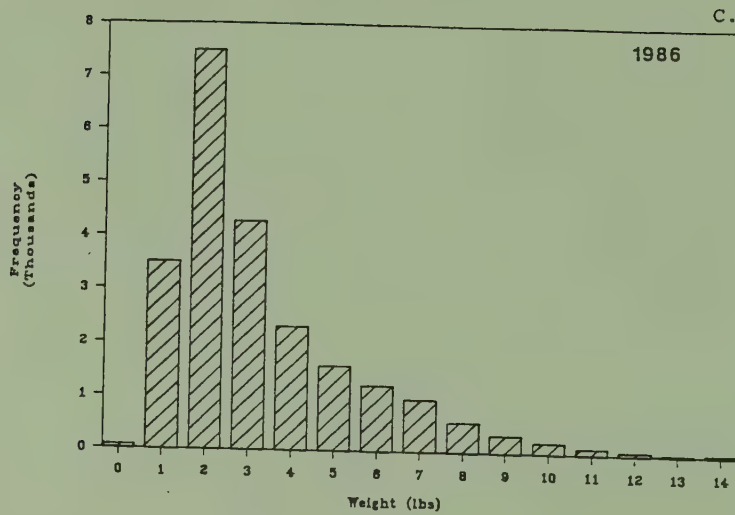


Figure 2.--Continued.

Opakapaka - MHI

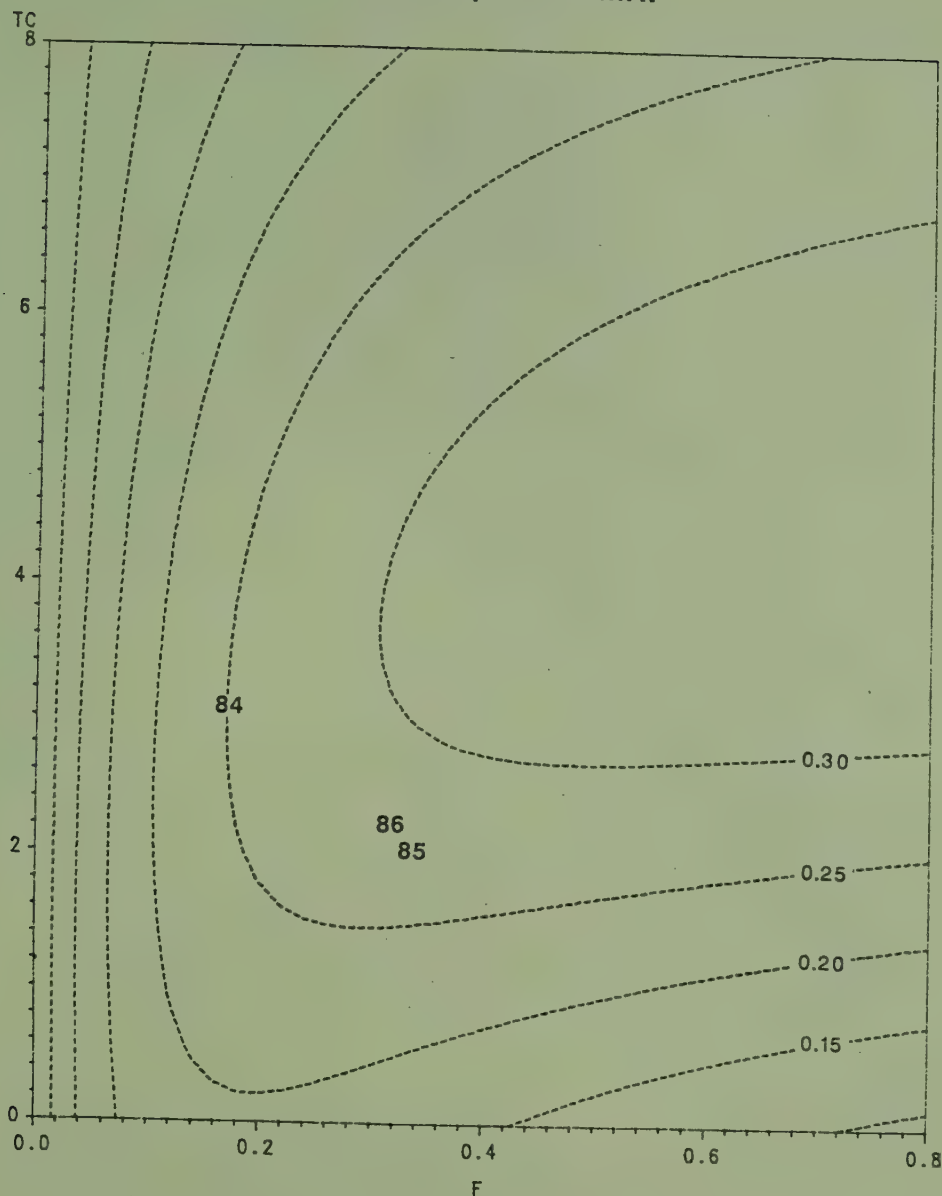


Figure 3.--Yield-per-recruit analysis for opakapaka caught in the main Hawaiian Islands. The unit of F is per year and the unit of t_0 is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

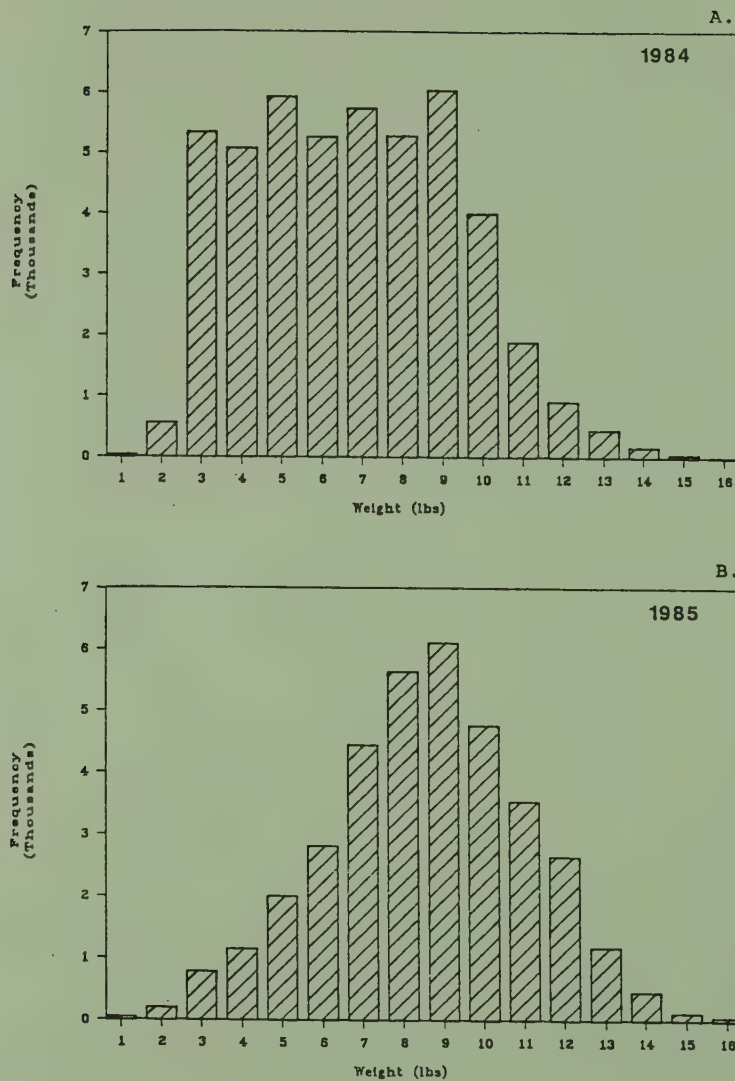


Figure 4.—Size structure of opakapaka landed from the Northwestern Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

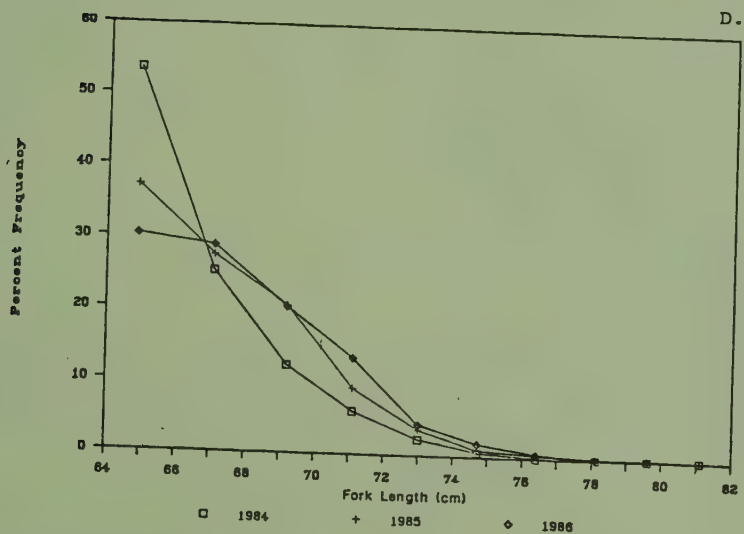
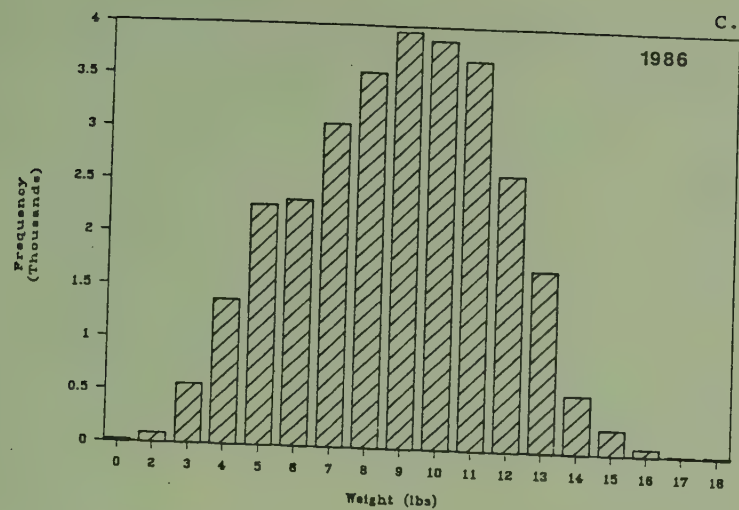


Figure 4.--Continued.

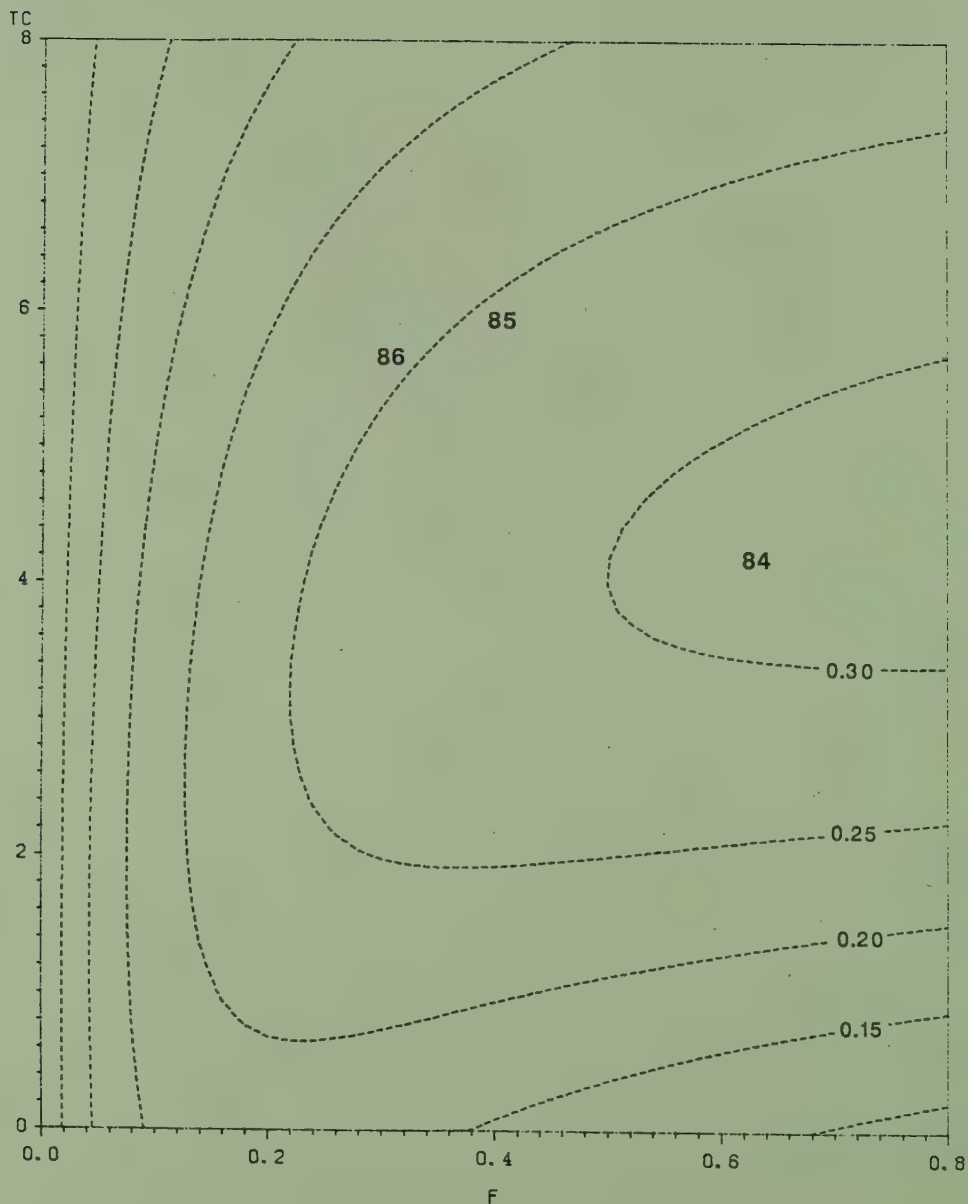


Figure 5.--Yield-per-recruit analysis for opakapaka caught in the Northwestern Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

Table 4.--Parameter estimates for bottom fish yield assessments:
 L_{∞} = von Bertalanffy asymptotic length (cm), $SE(L_{\infty})$ = standard error of L_{∞} , K = von Bertalanffy growth coefficient (per year), M = natural mortality rate (per year), W_{∞} = von Bertalanffy asymptotic weight (kg), w_c = weight at entry to the fishery (kg), t_c = age at entry to the fishery (year), F = fishing mortality rate (per year).

	Opakapaka		Onaga		Ehu		Uku	Hapuupuu		Butaguchi
	MHI	NWHI	MHI	NWHI	MHI	NWHI	MHI	MHI	NWHI	NWHI
L_{∞}	86.6	83.7	89.4	95.7	82.1	69.4	116.5	118.6	108.0	98.6
$SE(L_{\infty})$	1.62	3.12	0.63	1.59	2.21	1.06	3.64	0.70	1.02	1.62
K	0.146	0.150	0.143	0.137	0.151	0.169	0.120	0.119	0.126	—
M	0.293	0.299	0.287	0.274	0.303	0.338	0.241	0.238	0.253	—
W_{∞}	10.4	9.43	10.8	13.2	10.3	6.13	24.35	32.13	24.03	17.2
<u>1984</u>										
w_c	0.8	1.4	0.6	4.3	0.2	0.6	2.3	1.4	1.0	2.8
t_c	2.97	4.18	2.56	7.64	1.49	3.09	4.61	3.15	2.87	—
F	0.16	0.61	0.05	0.14	0.55	0.15	0.51	0.12	0.00	—
<u>1985</u>										
w_c	0.4	2.6	0.6	3.7	0.2	0.6	2.0	1.3	1.1	3.6
t_c	2.02	6.14	2.56	6.89	1.49	3.09	4.29	3.04	3.01	—
F	0.33	0.37	0.01	0.26	0.75	0.06	0.44	0.11	0.00	—
<u>1986</u>										
w_c	0.5	2.3	0.5	3.8	0.2	0.7	2.4	1.3	1.1	2.1
t_c	2.28	5.67	2.32	7.02	1.49	3.36	4.70	3.04	3.01	—
F	0.28	0.28	0.00	0.20	0.70	0.13	0.70	0.12	0.00	—

geographical patterns of fishing in the NWHI). Additionally there is a trend within the NWHI fishery to use larger size hooks, perhaps favoring the catch of larger fish (but see Ralston 1982).

Main Hawaiian Islands Onaga

The data presented in Table 4 and Figures 6 and 7 form the basis for a assessing the MHI fishery for onaga. The histograms indicate that, like the opakapaka, onaga are entering the fishery at a very small size (a 2-lb mode in 1985 and 1986). However, the length-frequency polygon overlay for the data from all 3 years (panel D, Fig. 6) provides no indication of a high mortality rate. The descending limbs of all three curves do not show excessive curvature. These results are indicative of a stock under light exploitation, as evidenced by the low estimates of fishing mortality in Figure 7. Even with the low age at entry to the fishery there is at present no indication that the resource is overfished. To the contrary, all the evidence suggests that MHI onaga are presently underutilized.

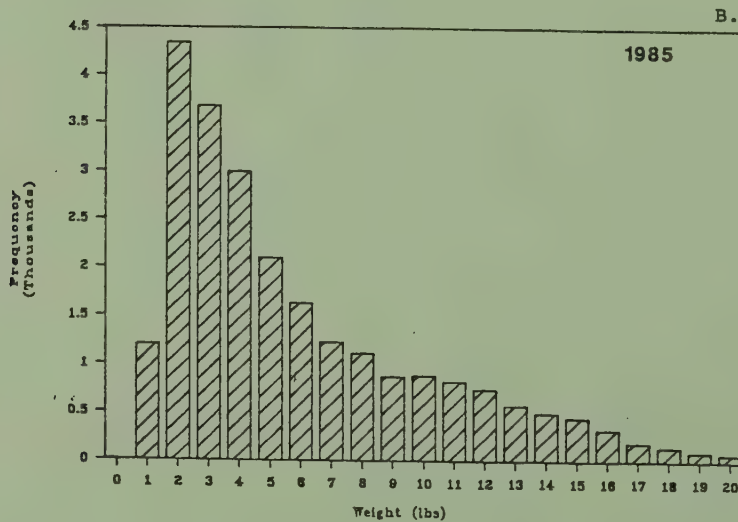
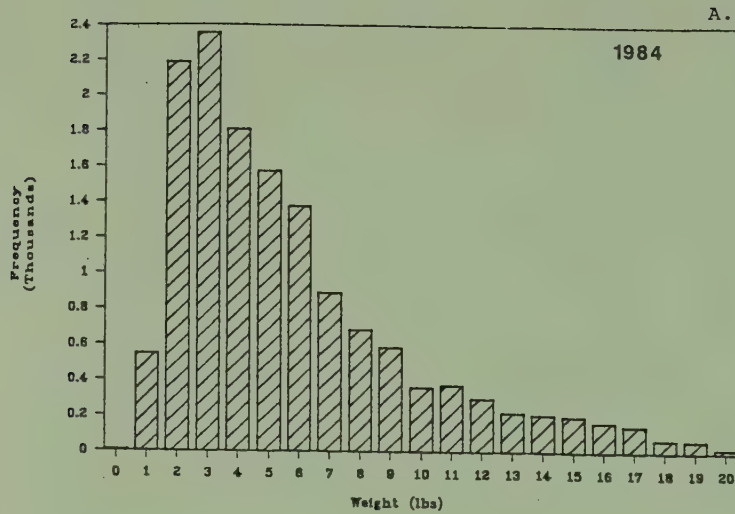


Figure 6.—Size structure of onaga landed from the main Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

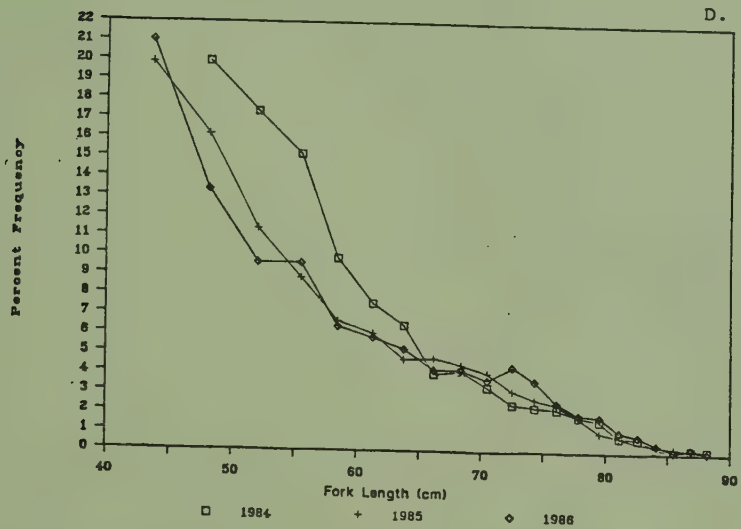
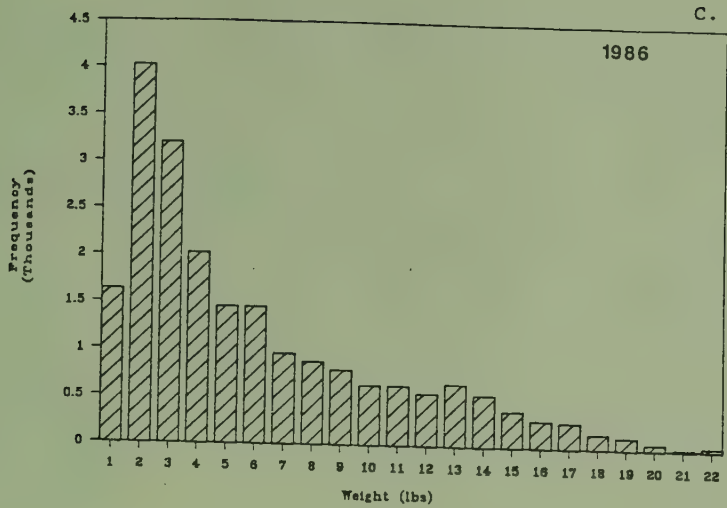


Figure 6.--Continued.

Onaga - MHI

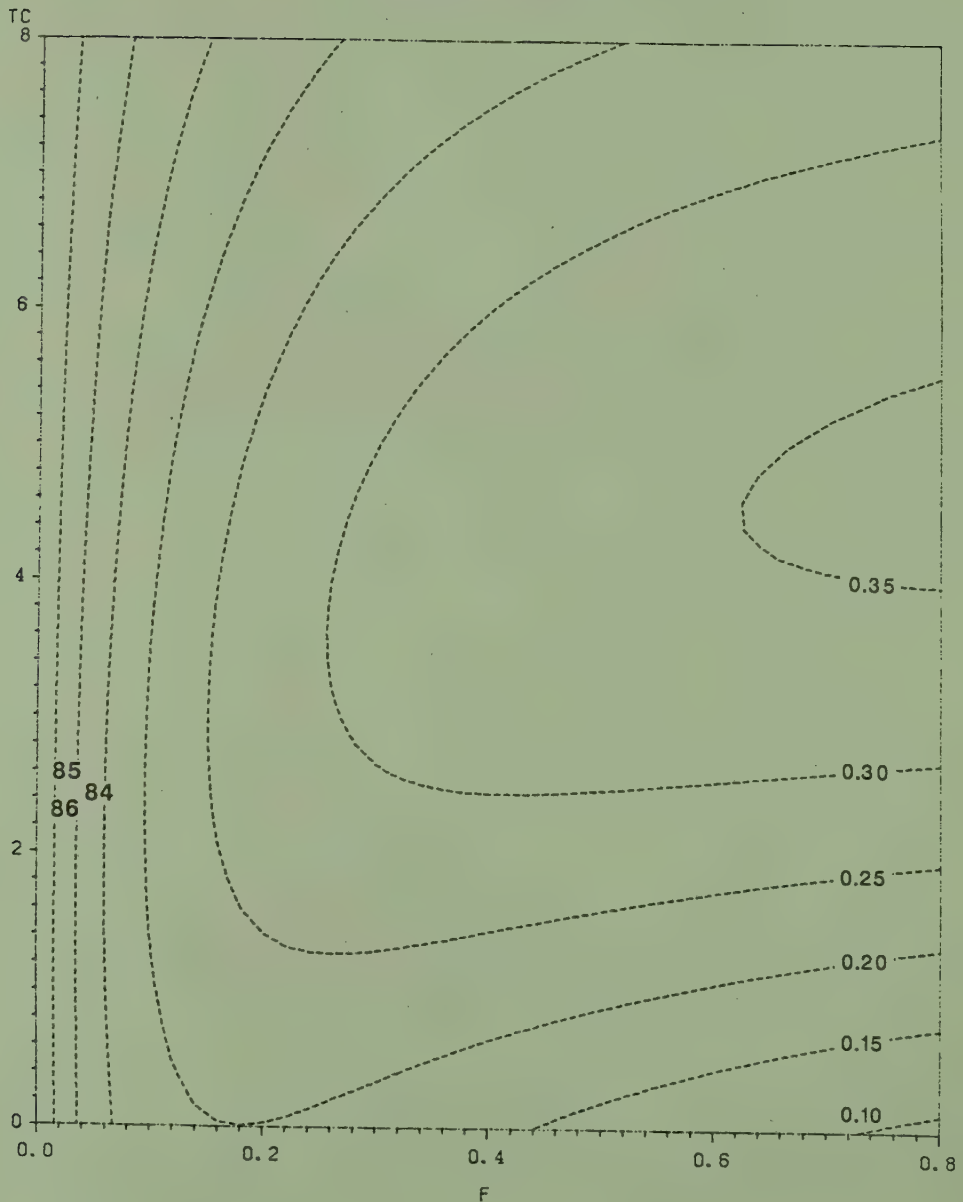


Figure 7.--Yield-per-recruit analysis for onaga caught in the main Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

Northwestern Hawaiian Islands Onaga

The analysis for NWHI onaga indicates a very high age at entry to the fishery (greater than 6 years) and a moderate level of fishing mortality (Table 4; Figs. 8 and 9). Because the modes of the histograms for 1984-86 are all in excess of 11 lb, the descending limbs presented in the relative length-frequency polygon overlay (panel D, Fig. 8) span a very small range in length, approximately 15 cm. This narrow range exacerbates the problem of estimating mortality rates due to the increased likelihood of substantial measurement and sampling errors. The fishery for onaga in the NWHI is relatively new, as evidenced by the fact that only 3.1 t were landed in 1984 (see discussion above). A change in size structure that would lead to a significant estimate of fishing mortality is not to be expected over so short a time interval. As pointed out by Ricker (1975), "survival rates which we estimate from age frequencies in a catch are ancient history." The same holds true for length frequencies. The estimates of fishing mortality for onaga caught in the NWHI (Table 4 and Fig. 9) are therefore in need of further validation and study.

Main Hawaiian Islands Ehu

Presented in Table 4 and Figures 10 and 11 are the results concerning the MHI fishery for ehu. It is clear that this species does not reach the large size characteristic of opakapaka and onaga. It is also apparent that, like the MHI fisheries for these other species, the age at entry for the ehu fishery is very low. The mode of all three histograms for the years 1984-86 is 1 lb. But unlike MHI onaga, substantial curvature exists in the descending limbs of the length-frequency polygons (panel D, Fig. 10). This characteristic is indicative of a high fishing mortality, at least for snappers and groupers (Ralston 1987). The yield-per-recruit analysis suggests that the fishery is overexploited (Fig. 11). Based on the data available, an increase in the age at entry to the fishery (t_c) would have a substantially beneficial effect on yield.

Northwestern Hawaiian Islands Ehu

A similar analysis was performed on the NWHI stock of ehu, the results of which are presented in Table 4 and Figures 12 and 13. When compared with the MHI, the ehu that are harvested in the NWHI are of a much larger size. Fish are entering the fishery at a weight three times that of the MHI (compare values of w_c in Table 4). Likewise, the age at entry is over twice as great. Neither is there excessive curvature in the descending limbs of the length-frequency distributions for 1984-86. The overall result (Fig. 13) is that the NWHI fishery for ehu is not fully utilized. Improvements to yield could be realized by increasing the existing level of fishing mortality.

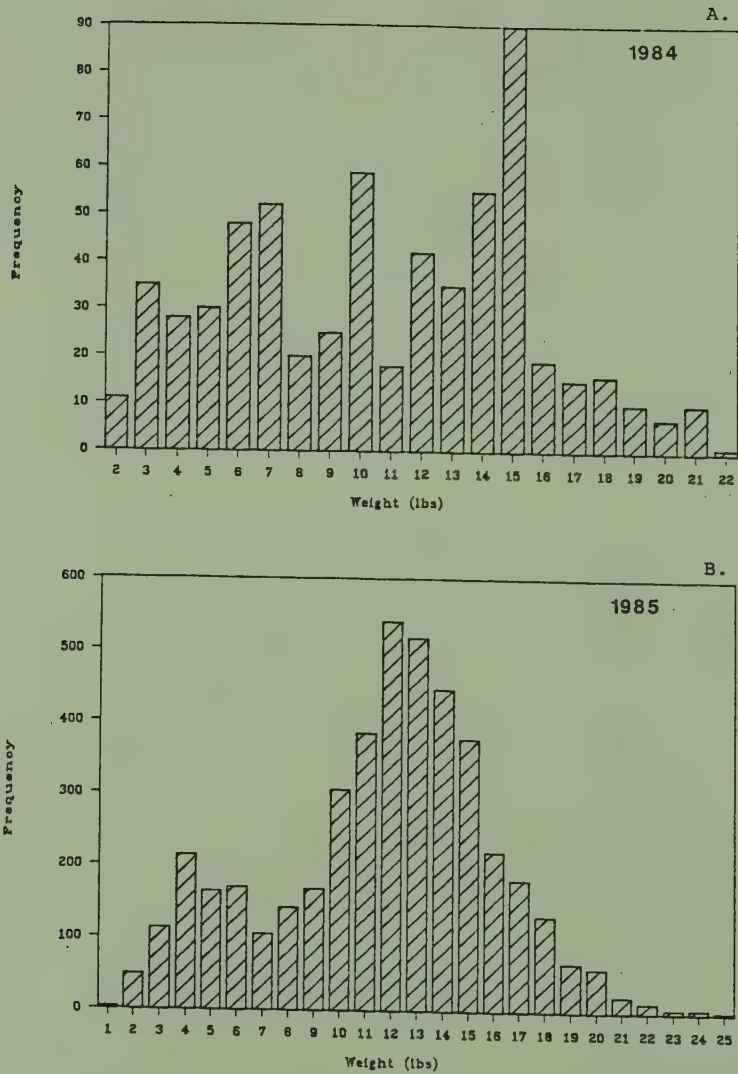


Figure 8.--Size structure of onaga landed from the North-western Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

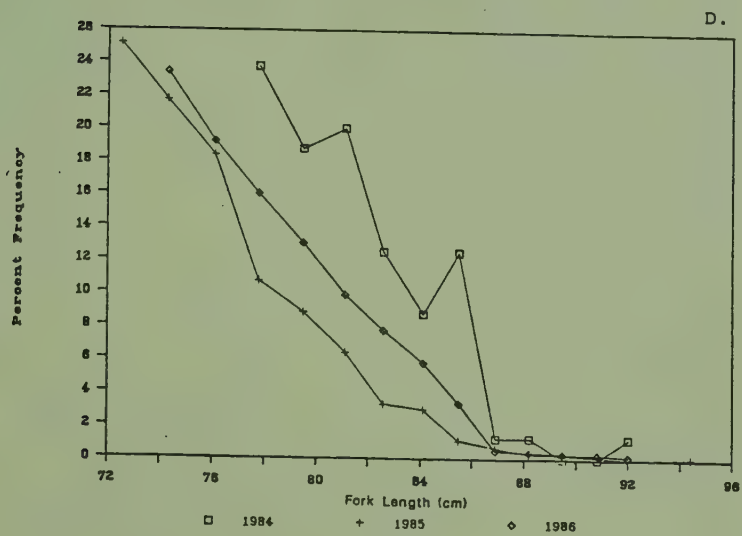
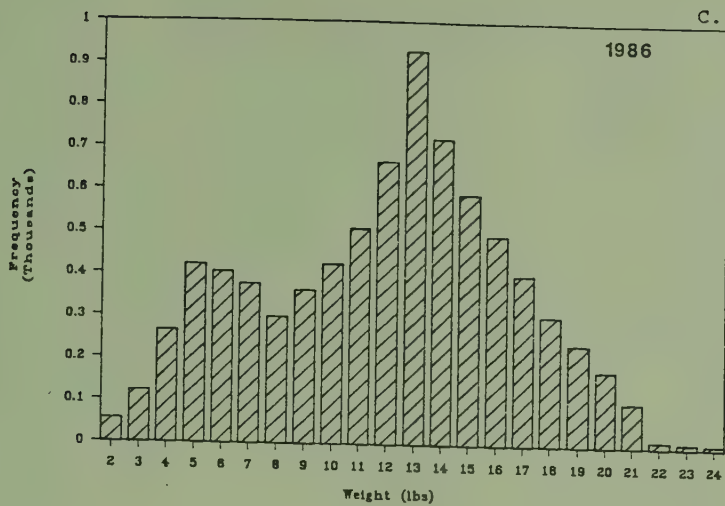


Figure 8.--Continued.

Onaga - NWHI

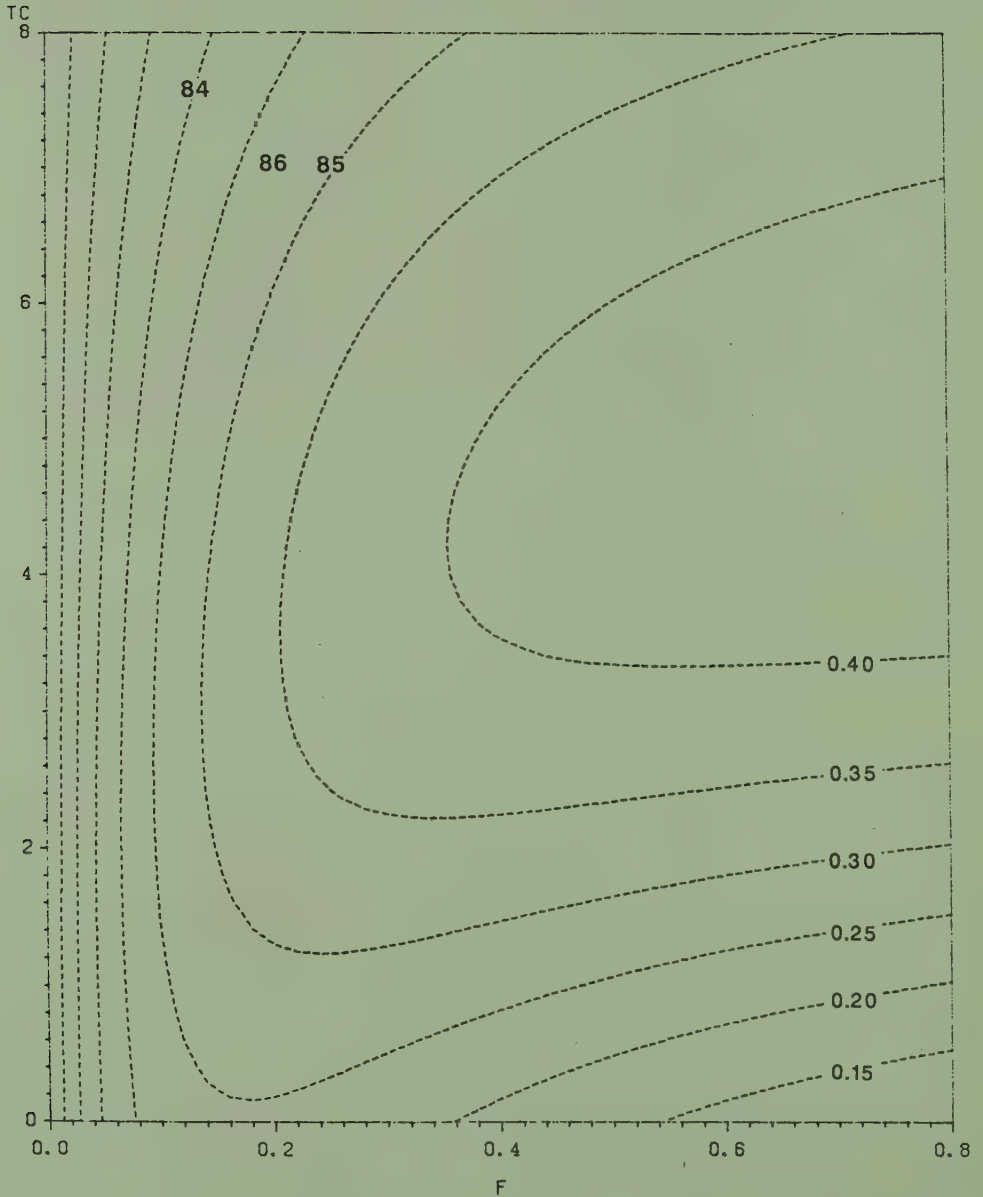


Figure 9.--Yield-per-recruit analysis for onaga caught in the Northwestern Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

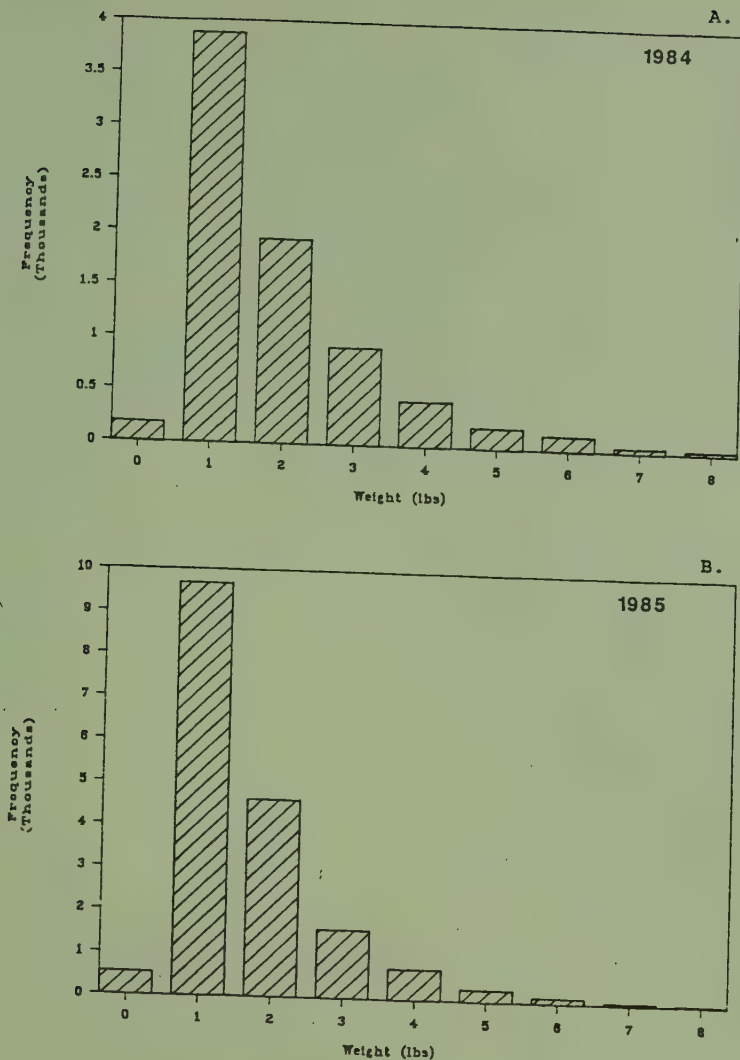


Figure 10.--Size structure of ehu landed from the main Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

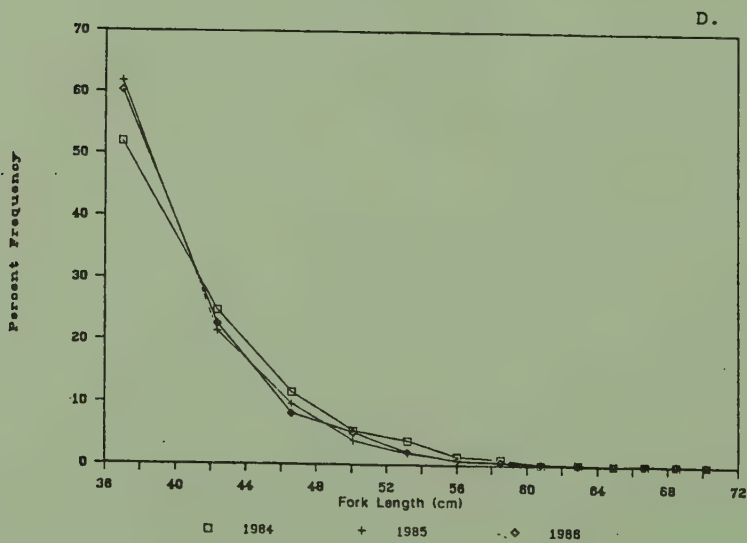
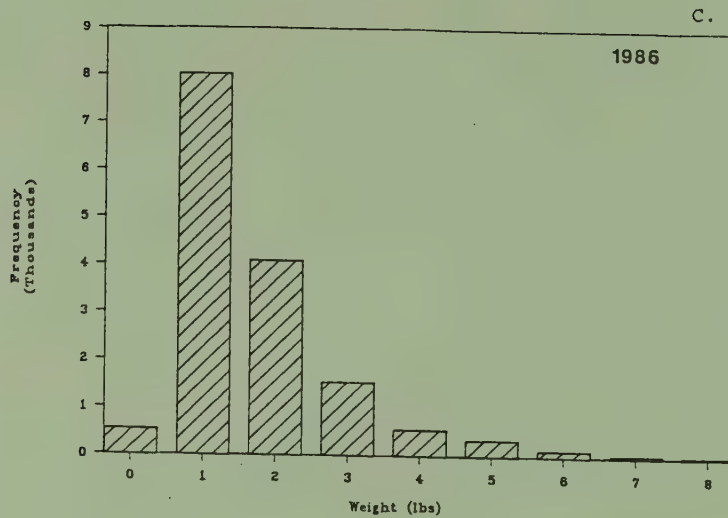


Figure 10.--Continued.

Ehu - MHI

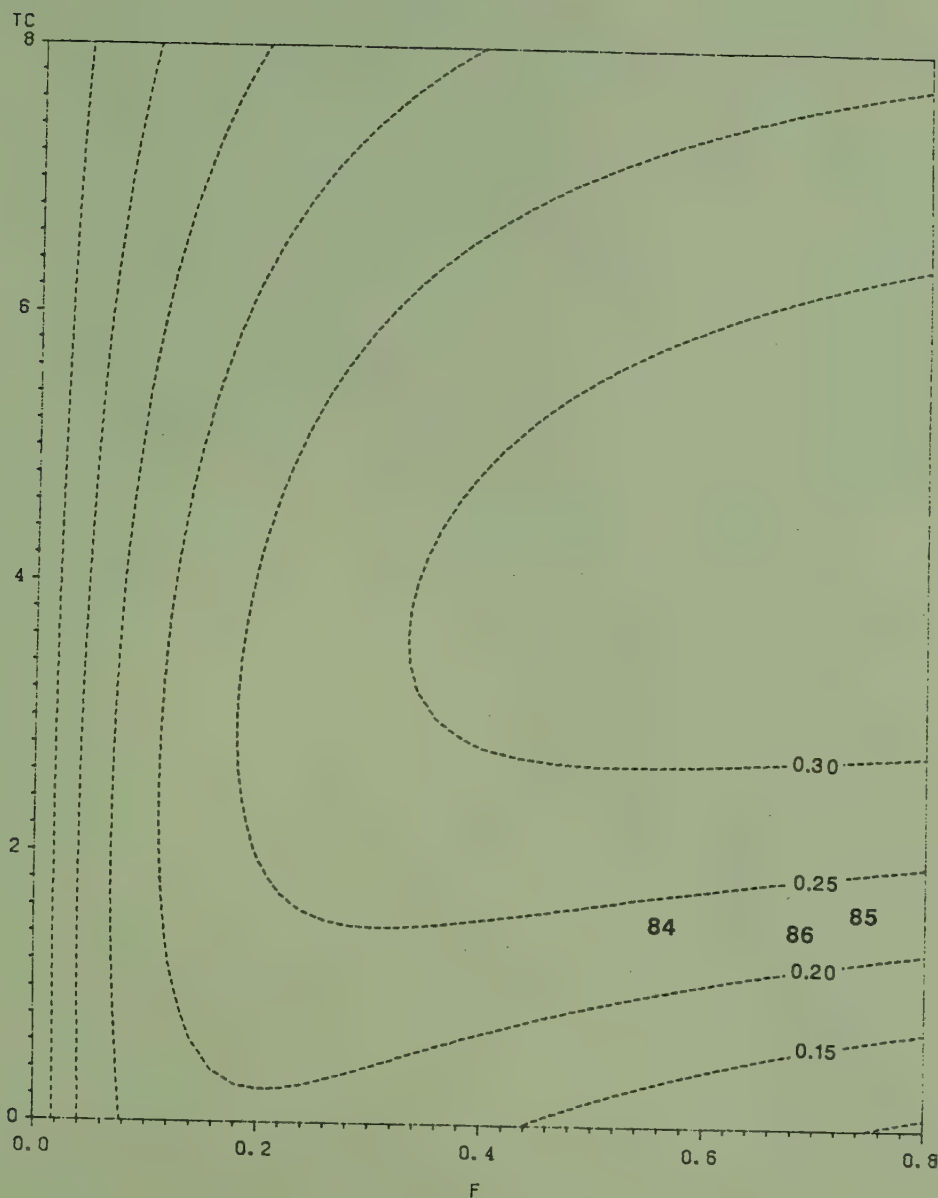


Figure 11.--Yield-per-recruit analysis for ehu caught in the main Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

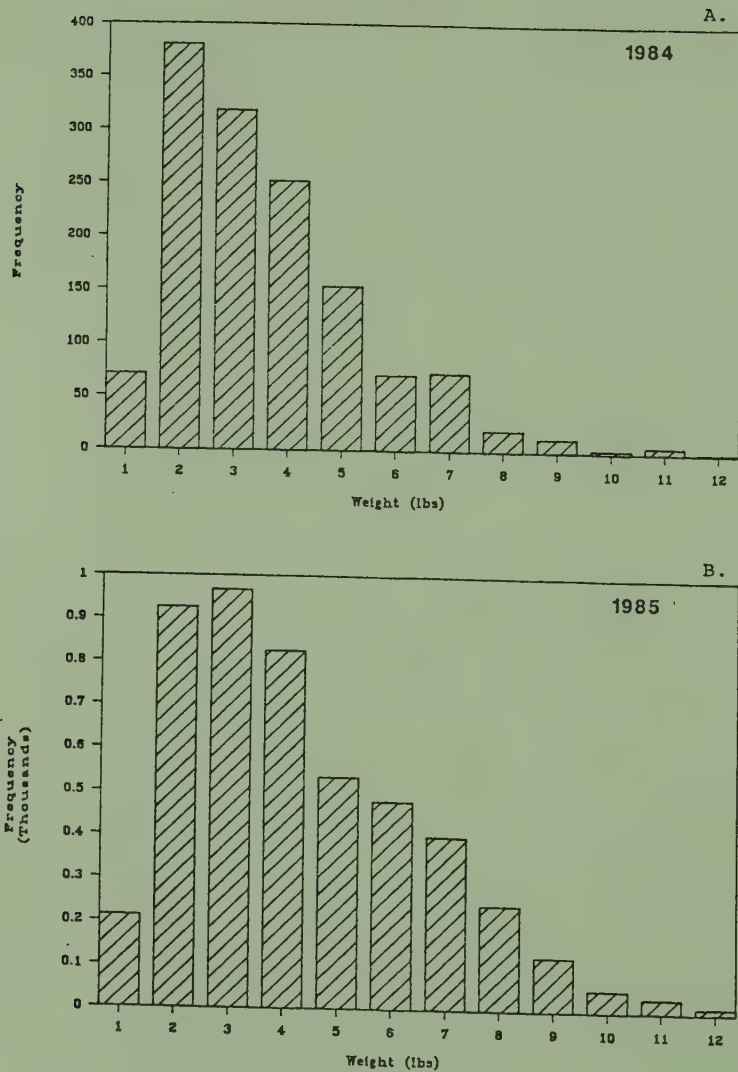


Figure 12.--Size structure of ehu landed from the North-western Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

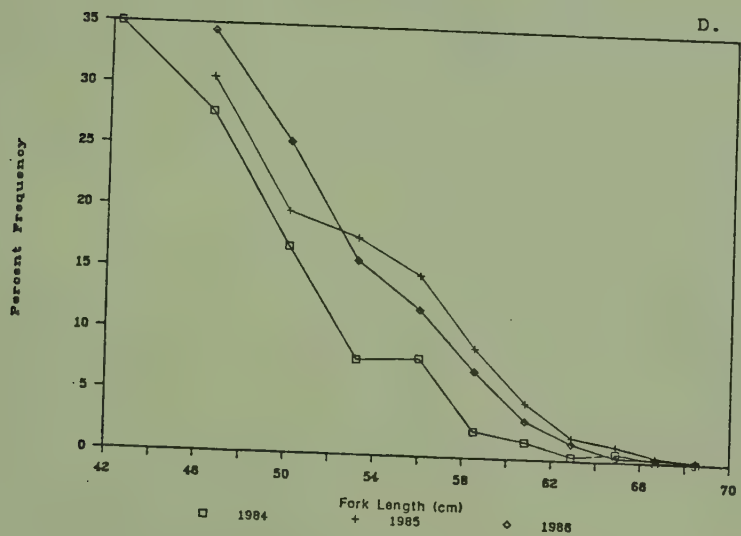
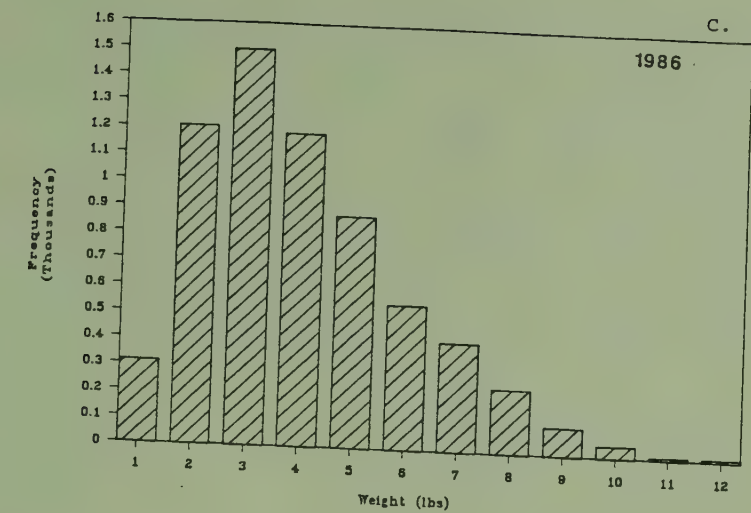


Figure 12.--Continued.

Ehu - NWHI

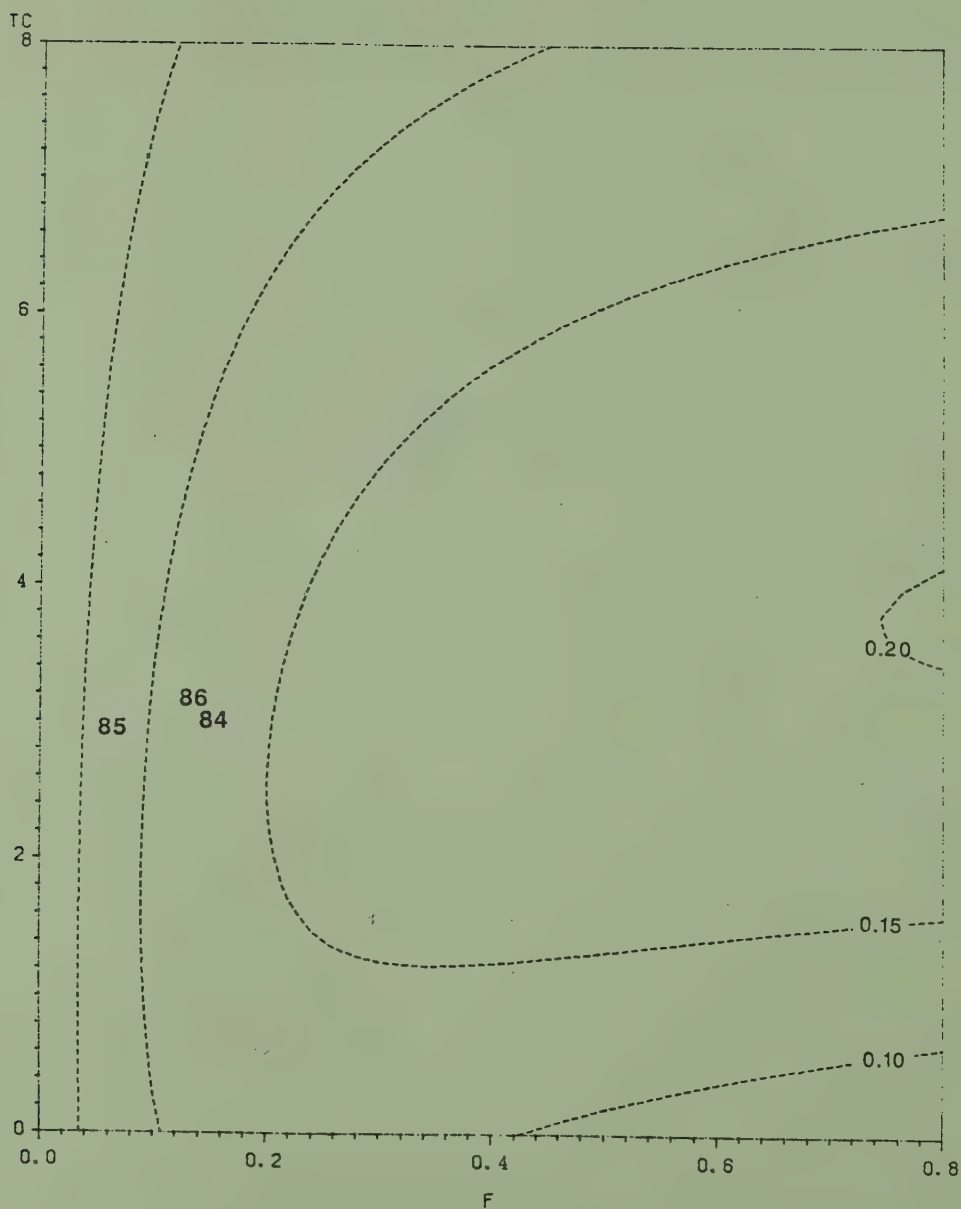


Figure 13.--Yield-per-recruit analysis for ehu caught in the Northwestern Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

Main Hawaiian Islands Uku

The MHI fishery for uku stands in contrast to the other MHI fisheries discussed so far. The weight and age at entry to the fishery (Table 4) are much greater than for opakapaka, onaga, and ehu. The poor representation of small uku in the MHI catch (Fig. 14) is believed to be due to their unavailability. As indicated previously, the uku fishery generally targets fish that are aggregated for spawning, effectively conserving the pre-reproductive portion of the resource. Nonetheless, the MHI stock of uku is intensively exploited. The descending limbs of the relative length-frequency distributions for 1984-86 all demonstrate substantial curvature. Even with a much greater age at entry than the MHI fisheries already examined, the uku fishery would appear to be slightly overexploited (Fig. 15). Certainly no reduction in t_c is desirable at this time, and fishing mortality is already much greater than natural mortality (Table 4), a warning sign for snapper and grouper fisheries (Polovina 1987; Ralston 1987).

Main Hawaiian Islands Hapuupuu

The data presented in Table 4 and Figures 16 and 17 summarize the biological assessment and yield analysis for MHI hapuupuu. The weight at entry to the fishery is not great (about 1.3 kg), but neither is the estimated fishing mortality rate. In fact, the estimated position of the fishery on the isopleth surface from 1984 to 1986 places it close to the eumetric fishing line. Thus, given the prevailing level of fishing mortality, the current age at entry to the fishery (t_c) is near optimal. If fishing mortality were to increase very much, however, an increase in t_c would be desirable.

Northwestern Hawaiian Islands Hapuupuu

Hapuupuu harvested in the NWHI actually become vulnerable to fishing at a smaller size and age than do MHI conspecifics (Table 4). This is the only species to demonstrate this reversal of form. Nonetheless, as evidenced by the near linear descending limbs of the three length-frequency polygons in panel D of Figure 18, the ratio of total mortality rate to von Bertalanffy growth coefficient (Z/K) is approximately 2.0. A ratio of 2.0 is typically indicative of an unexploited grouper stock (Ralston 1979). Hence the yield-per-recruit analysis (Fig. 19) shows the NWHI stock of hapuupuu to be underutilized. If true, a moderate increase in fishing effort should produce a major increase in yield per hapuupuu recruit.

Northwestern Hawaiian Islands Butaguchi

The butaguchi is a carangid and cannot be analyzed using the methods employed up to this point. For all the species treated so far, the von Bertalanffy growth coefficient (K) and natural mortality rate (M) were estimated using the regression equations provided in Manooch (1987) and Ralston (1987). These two equations relate specifically to snappers and groupers

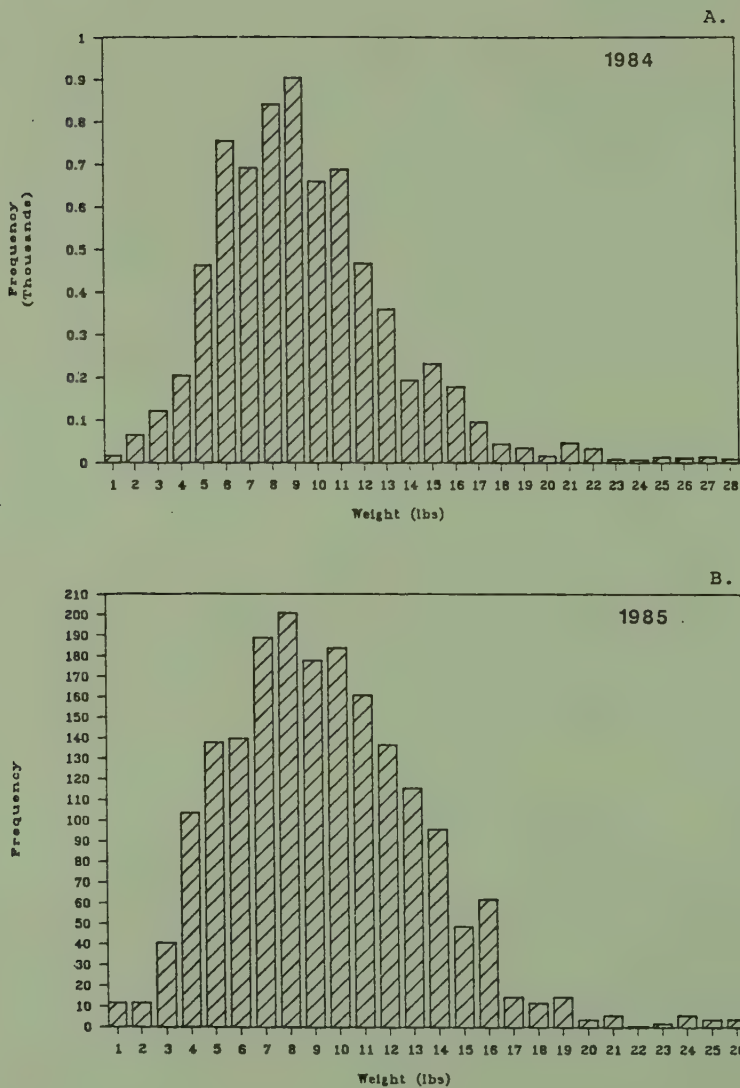


Figure 14.--Size structure of uku landed from the main Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

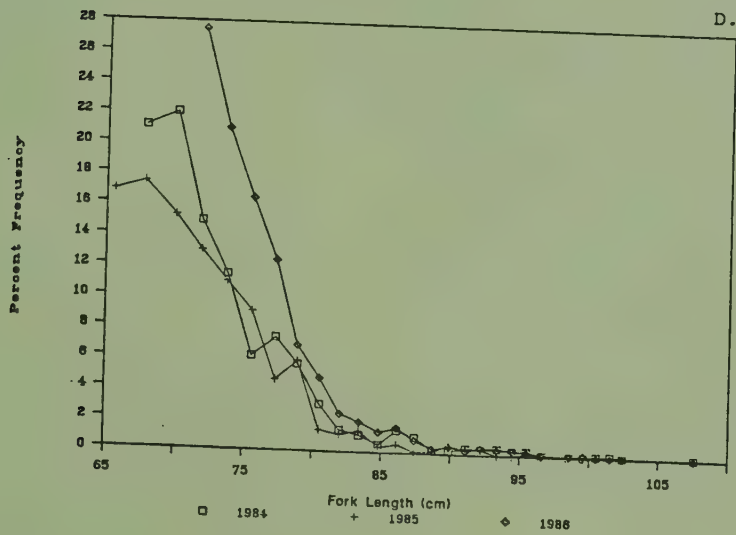
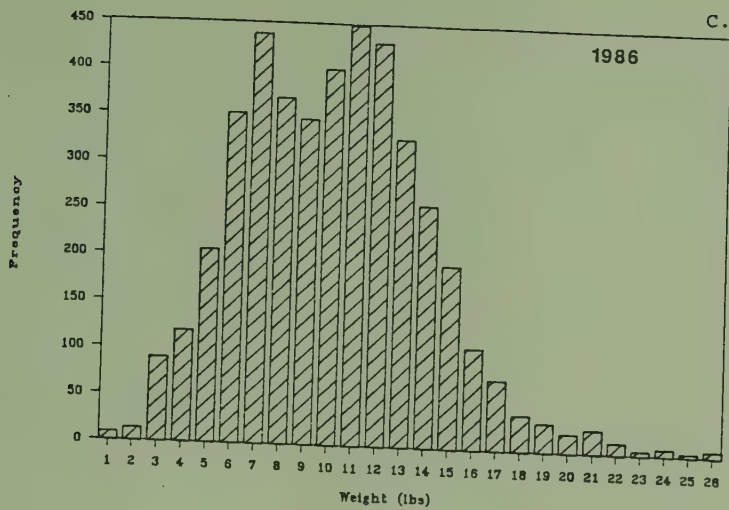


Figure 14.--Continued.

Uku - MHI

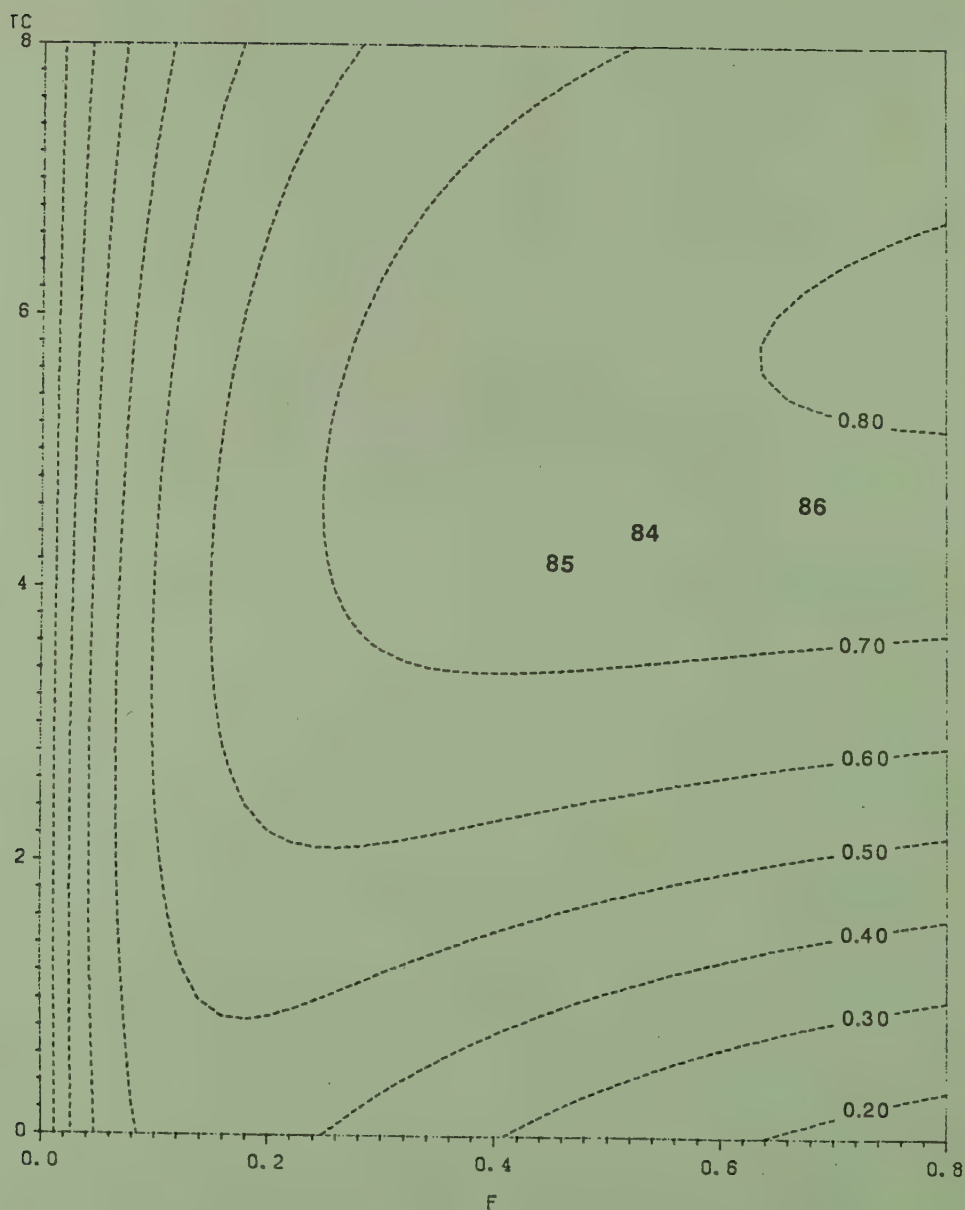


Figure 15.--Yield-per-recruit analysis for uku caught in the main Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

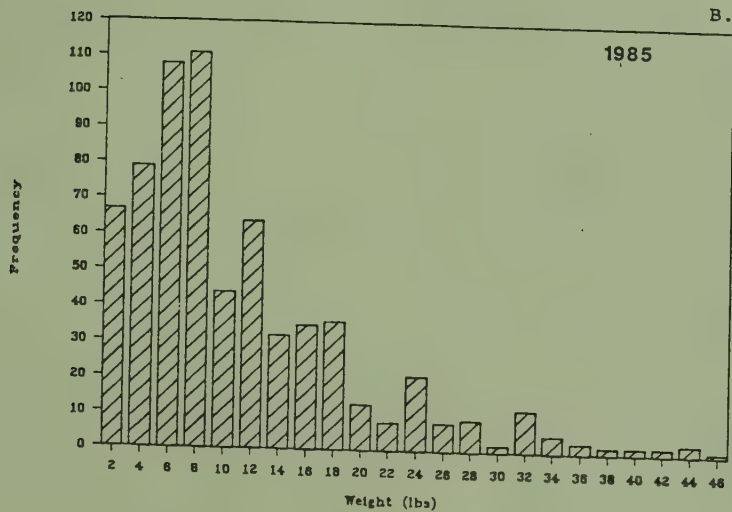
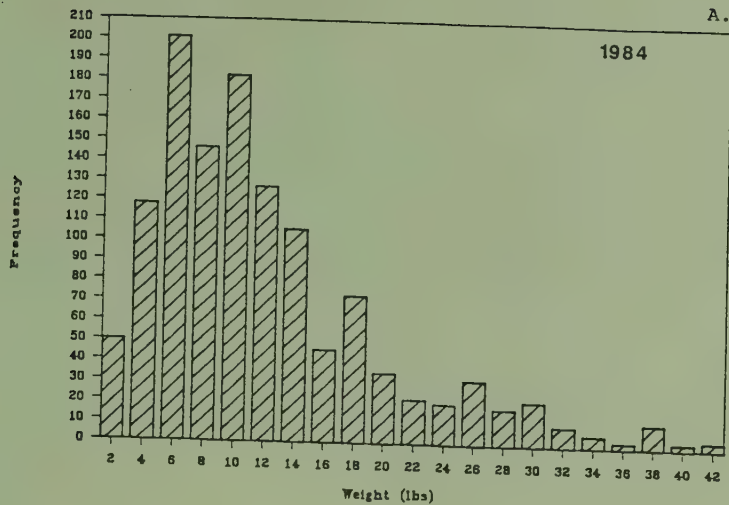


Figure 16.--Size structure of hapuupuu landed from the main Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

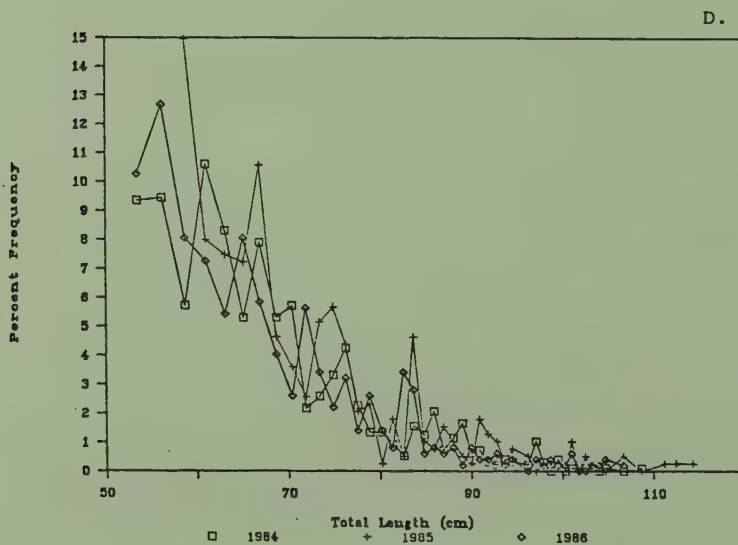
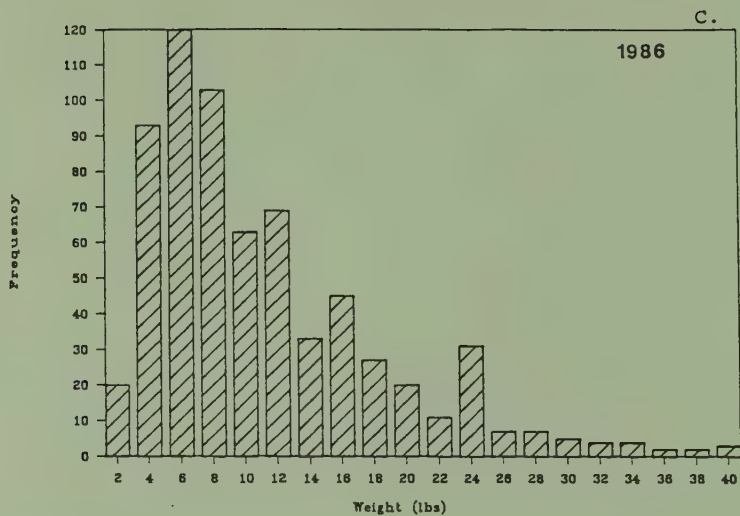


Figure 16.--Continued.

Hapuupuu - MHI

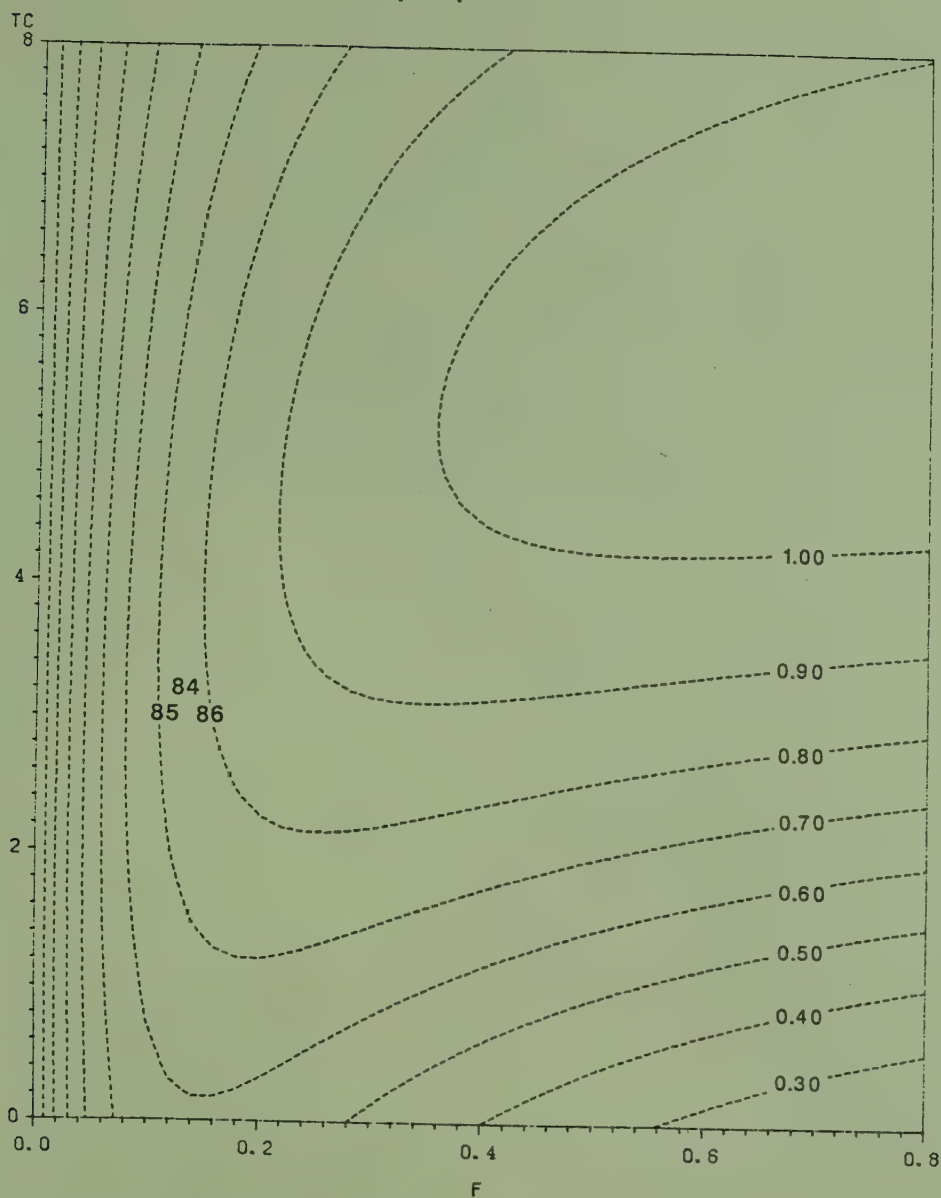


Figure 17.--Yield-per-recruit analysis for hapuupuu caught in the main Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

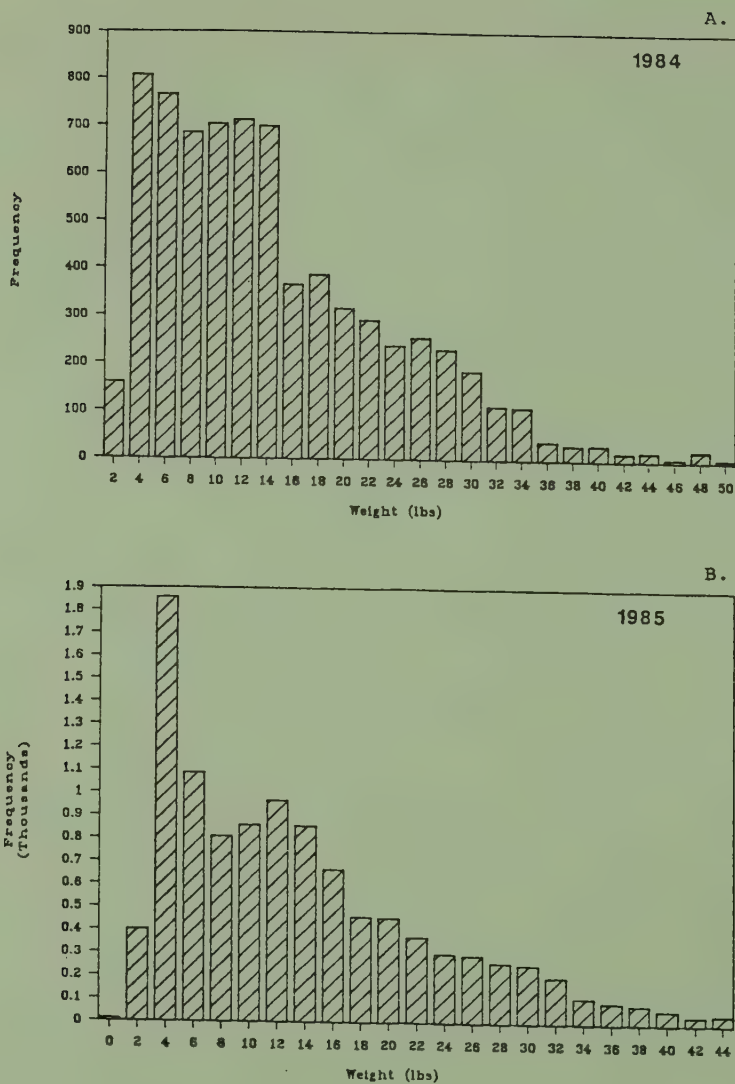


Figure 18.—Size structure of hapuupuu landed from the Northwestern Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

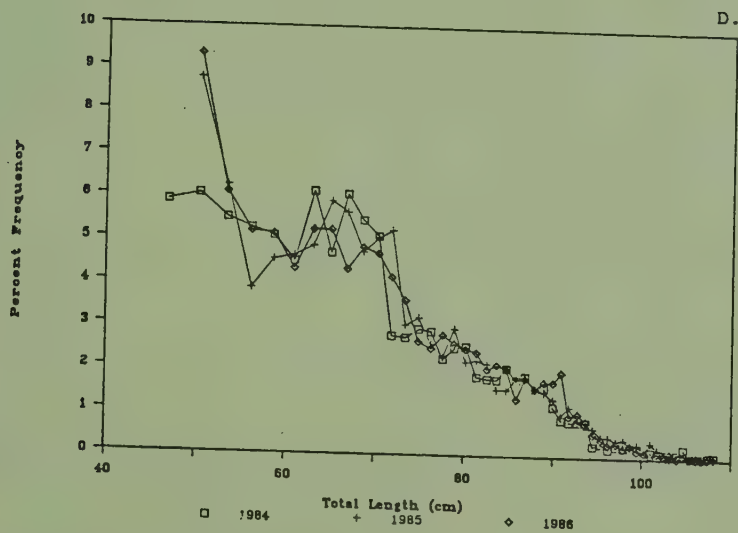
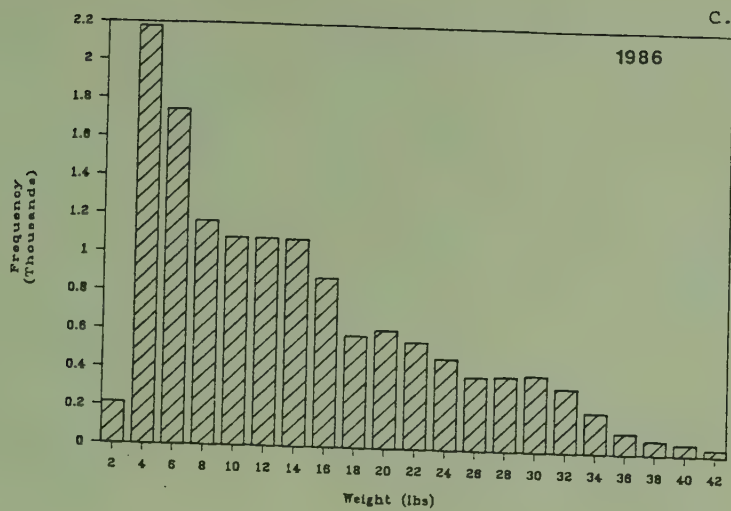


Figure 18.--Continued.

Hapuupuu - NWHI

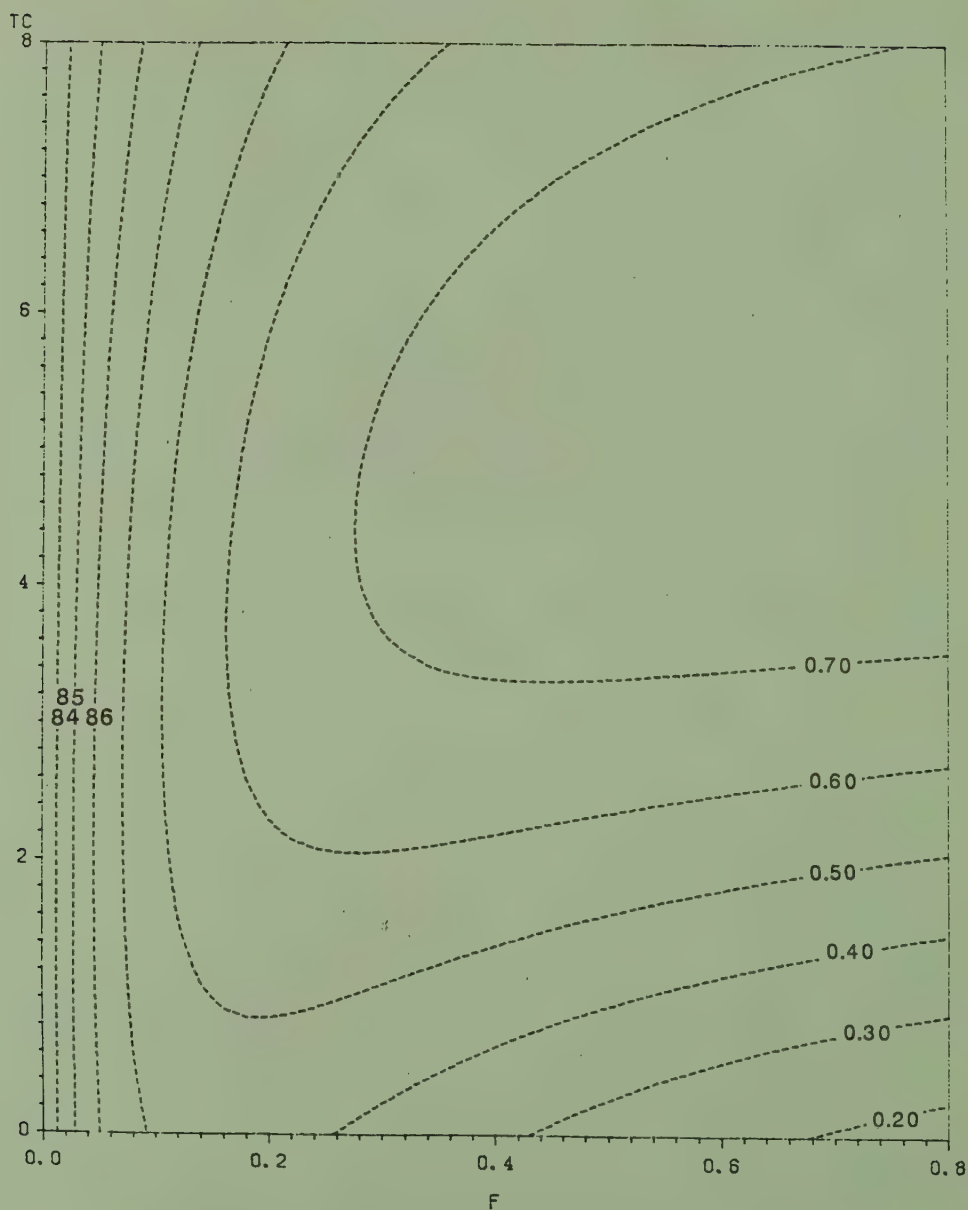


Figure 19.--Yield-per-recruit analysis for hapuupuu caught in the Northwestern Hawaiian Islands. The unit of F is per year and the unit of t_c is years. Contoured isopleths represent the locus of points corresponding to equal yield per recruit (kg). The estimated positions of the fishery during the years 1984, 1985, and 1986 are plotted.

and, without some compelling reason, it is unjustifiable to apply them to unrelated taxa. A preliminary analysis of size structure is possible, however, the results of which are presented in Table 4 and Figure 20.

Weight-frequency distributions for butaguchi landed from the NWHI are quite broad and flat (platykurtic). In such situations the detection of a mode becomes increasingly difficult and arbitrary. Still, as illustrated in the length-frequency polygons for this species (panel D), the descending limb for 1986 shows little curvature. Those for 1984 and 1985 appear to exhibit more severe levels of mortality. Like the NWHI harvest of opakapaka discussed above, this pattern is consistent with a change in the geographical pattern of fishing activity between these time periods.

Geographical Patterns of Fishing in the Northwestern Hawaiian Islands

Even though detailed information on the geographical origin of bottom fish landings did not become widely available until 1986, it is possible to examine the pattern of fishing activity in the NWHI with the existing data. Caution must be exercised, however, because only a small portion of the 1984 and 1985 NWHI bottom fish landings include bank specific fishing locations (15 and 8%, respectively).

The results presented in Figures 21 and 22 show how the geographical pattern of fishing in the NWHI has altered in the last 3 years. In Figure 21 the areal distribution of the opakapaka catch is shown in each year since 1984. Note that the fishing banks are listed horizontally and are arranged in rank order relative to distance up the archipelago. For example, Middle Bank (MD) is the closest to Honolulu, while Pearl and Hermes Reef (PH) is the most distant. The pattern is mimicked in Figure 22, in which the geographical pattern of total bottom fish landings is summarized.

The data presented in these figures strongly suggest that in 1984 and 1985 the center of bottom fishing activity in the NWHI was in the vicinity of Twin Banks, Necker Island, French Frigate Shoals, and Brooks Banks. In fact, the "expected" or average distance to the fishing grounds for a unit weight of opakapaka harvested in 1984 was 498 nmi from Honolulu (Brooks Banks). The comparable figure for 1985 was 411 nmi (Necker Island, French Frigate Shoals). Because of the sparse representation of bank specific information available for these 2 years, however, it is unlikely that this slight difference in the mean distance to the fishing grounds represents any sort of meaningful alteration in fishing activity.

In contrast, bottom fish fishing activity in 1986 had extended much farther up the Hawaiian chain. Significant landings of opakapaka and other bottom fishes were taken at Gardner Pinnacle, Raita Bank, Maro Reef, Laysan Island, Northampton Seamounts, Pioneer Bank, and especially Lisianski Island. The expected distance to the fishing grounds for a unit weight of opakapaka in 1986 was 771 nmi, equivalent to traveling as far as Maro Reef and Laysan Island.

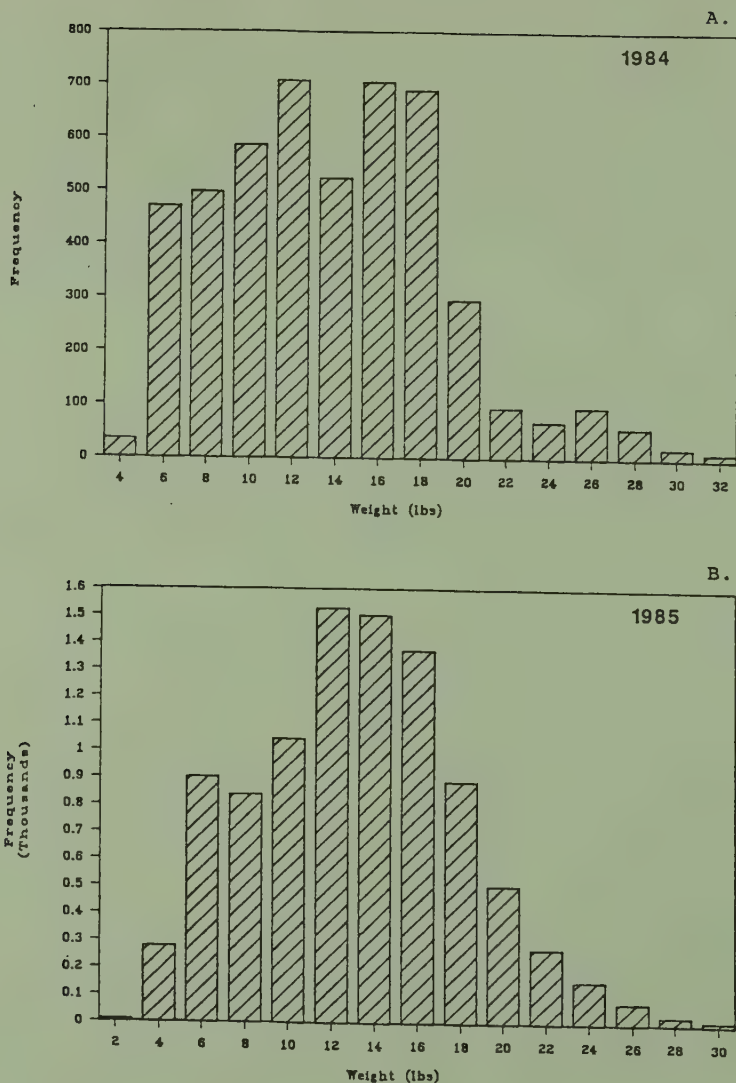


Figure 20.--Size structure of butaguchi landed from the Northwestern Hawaiian Islands over the period 1984-86. The first three panels (A-C) provide the weight-frequency histograms for each year. The fourth panel (D) is an overlay of the annual relative length-frequency polygons.

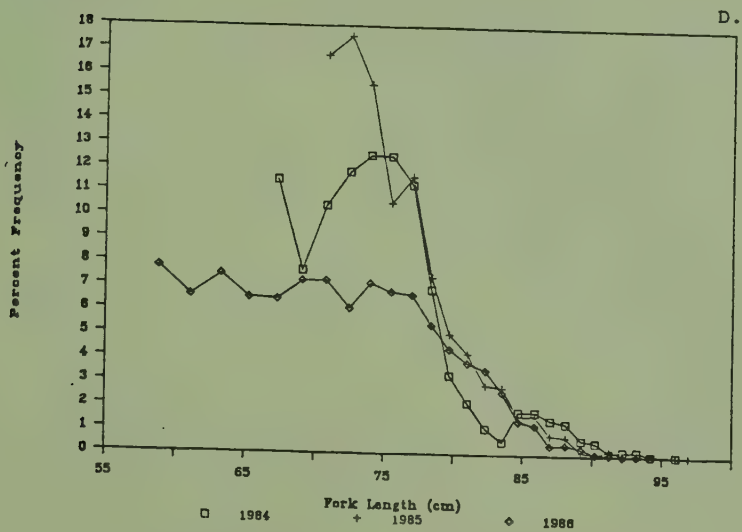
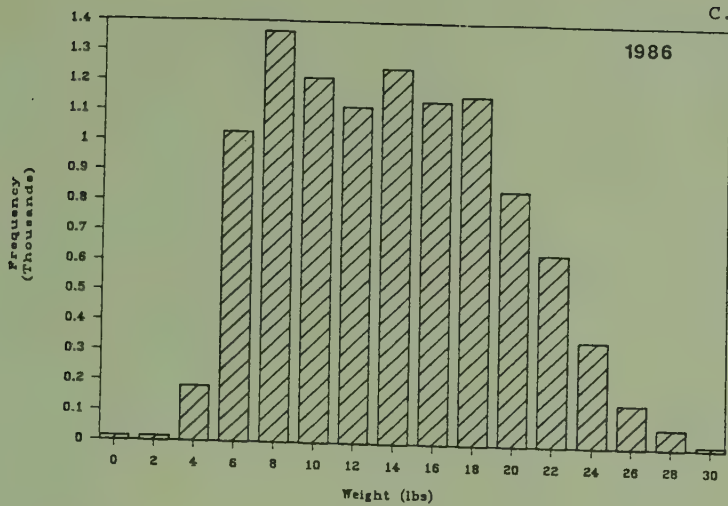


Figure 20.--Continued.

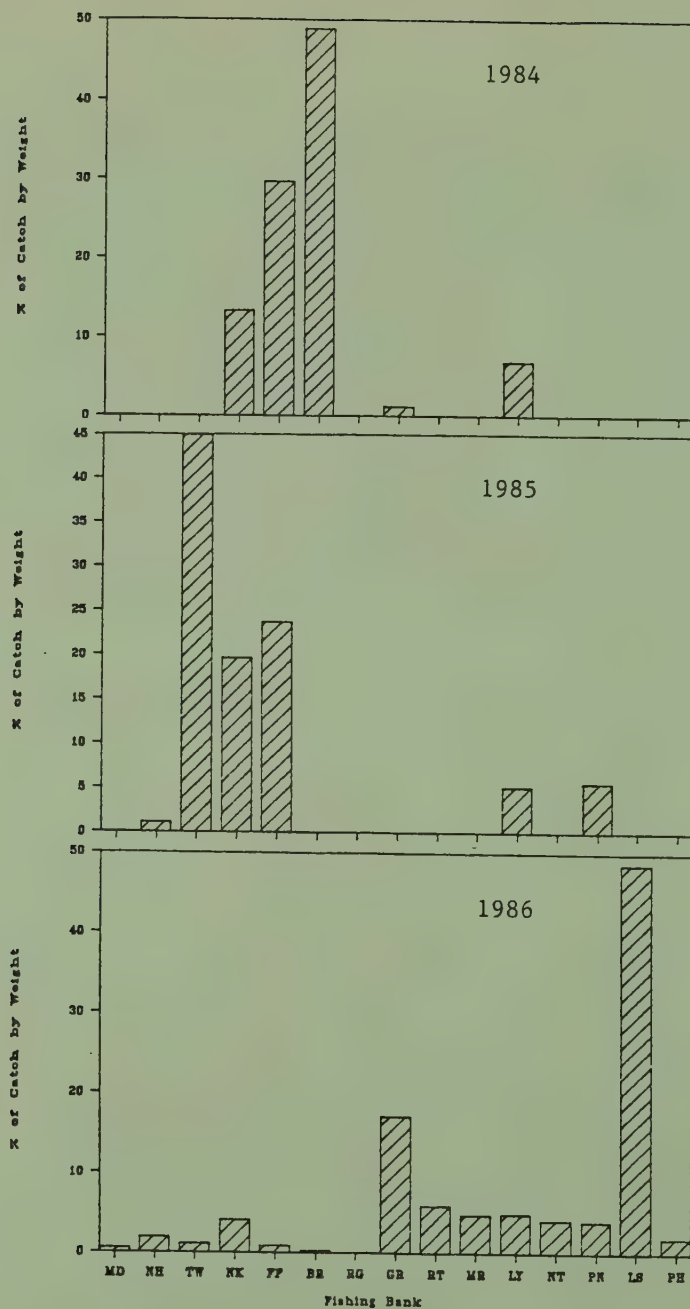


Figure 21.--Locations of opakapaka harvests in the North-western Hawaiian Islands (1984-86). Fishing bank abbreviations are as follows: MD = Middle Bank, NH = Nihoa, TW = Twin Banks, NK = Necker Island, FF = French Frigate Shoals, BR = Brooks Banks, RG = St. Rogatien Banks, GR = Gardner Pinnacles, RT = Raita Bank, MR = Maro Reef, LY = Laysan Island, NT = Northampton Seamounts, PN = Pioneer Bank, LS = Lisianski Island, PH = Pearl and Hermes Reef.

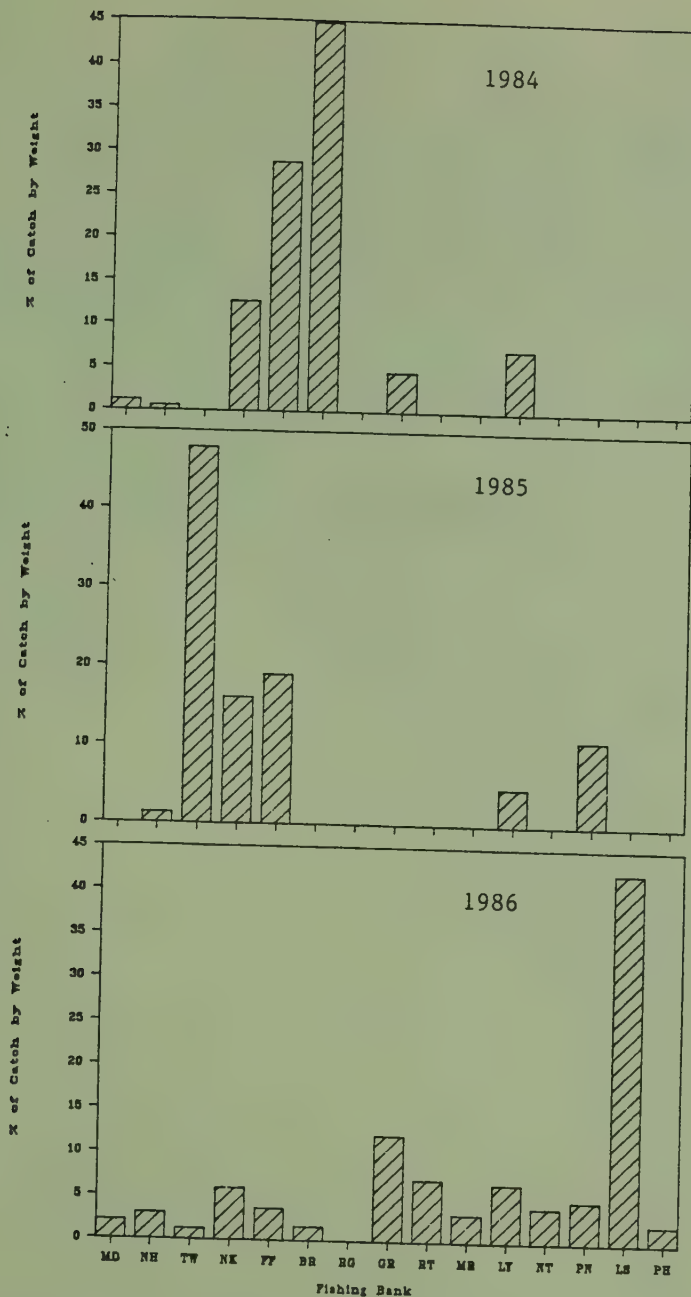


Figure 22.--Locations of bottom fish harvests in the Northwestern Hawaiian Islands (1984-86). Fishing bank abbreviations are as follows: MD = Middle Bank, NH = Nihoa, TW = Twin Banks, NK = Necker Island, FF = French Frigate Shoals, BR = Brooks Banks, RG = St. Rogatien Banks, GR = Gardner Pinnacles, RT = Raita Bank, MR = Maro Reef, LY = Laysan Island, NT = Northampton Seamounts, PN = Pioneer Bank, LS = Lisianski Island, PH = Pearl and Hermes Reef.

These results illustrate that the fishing activities of the bottom fishing fleet in the NWHI have been in a dynamic state of flux. Fishermen are traveling greater distances up the Hawaiian Island chain in order to encounter the higher catch rates that characterize unexploited fishing grounds. The move up the archipelago has occurred in conjunction with what has been an overall decline in the NWHI harvest of opakapaka, the previous mainstay of the fishery. Significantly, the natural abundance of opakapaka is known to decline with the distance traveled up the NWHI (Moffitt 1980; Humphreys 1986). The "fishing-up" process (*sensu* Ricker 1975) for this species in the NWHI is now likely complete.

Bottom Fishing Effort and CPUE in the Northwestern Hawaiian Islands

For the years 1984-86 there were 144, 164, and 166 recorded "bottom fishing trips" to the NWHI, respectively. Due to a small catch many of these represented an ineffective application of fishing effort, however. Thus, in order to qualify as an effective fishing trip (the nominal unit of fishing effort), at least 454 kg (1,000 lb) of bottom fish needed to be landed and marketed at the wholesale market. Under this constraint there were 108, 136, and 140 effective bottom fish fishing trips to the NWHI over the time period in question. Moreover, the mean catches (lb) of bottom fish per effective trip (CPUE) were 4,888, 5,332, and 5,539 during the 1984-86 period. From these data in isolation there is no indication of a decline in the abundance of bottom fish in the NWHI.

In order to more closely assess changes in NWHI bottom fish catch rates, the success of individual fishing vessels was followed over the last 3 years. The results presented in Table 5 document the annual CPUE statistics (mean pounds per effective fishing trip) for the 30 different vessels that actively participated in the fishery. In 1984 there were a total of 18 boats, in 1985 there were 21, and in 1986 there were 22 vessels contributing significantly to the fishery. Thus, the balance of entry to and exit from the fishery has resulted in a net gain in each year for which there are data. In terms of participants the fishery is growing.

Close examination of the data in Table 5 reveals 11 boats that fished all 3 years. Standardizing annual comparisons of CPUE by restricting the computation of sampling statistics to a uniform set of sampling units (*i.e.*, vessels) should increase the power of the comparison to detect change. The mean catch rates of the 11 vessels that participated in the NWHI fishery during all 3 years for which there are data are 4,190, 4,230, and 4,866 lb per effective bottom fish fishing trip, respectively. Standard deviations about these means are 1,750, 1,827, and 1,886. These figures confirm the prior comparison based upon the entire fleet. Overall there has been no decline in the total bottom fish catch per NWHI fishing trip since 1984. If anything, there has been a slight increase.

Table 5.--Bottom fish CPUE in the Northwestern Hawaiian Islands. The catch rates (pounds per trip) of 30 different fishings vessels are listed for the years 1984-86. Note that 11 different vessels (H-R) fished in all 3 years.

Vessel	1984	1985	1986
1. A	6,202	--	--
2. B	2,554	--	--
3. C	10,812	--	--
4. D	2,905	--	--
5. E	1,489	1,042	--
6. F	1,391	2,130	--
7. G	3,409	4,224	--
8. H	4,585	3,040	5,100
9. I	5,147	5,684	3,296
10. J	4,743	3,630	3,526
11. K	3,757	2,869	4,806
12. L	3,175	4,354	4,091
13. M	3,725	3,248	6,385
14. N	2,229	5,959	5,653
15. O	8,529	8,303	6,465
16. P	4,143	4,398	4,402
17. Q	1,922	1,744	1,368
18. R	4,132	3,304	8,434
19. S	--	2,397	1,466
20. T	--	1,708	2,014
21. U	--	7,242	7,706
22. V	--	7,471	6,323
23. W	--	8,994	11,328
24. X	--	4,038	1,233
25. Y	--	5,735	--
26. Z	--	--	1,608
27. AA	--	--	3,756
28. BB	--	--	6,893
29. CC	--	--	1,225
30. DD	--	--	11,457

DISCUSSION

In attempting to synthesize the information presented here it is useful to review and reiterate the key assumptions of the analysis, of which there are five.

The first assumption is that the size structure of the bottom fish catch is adequately represented by the methods discussed in Ralston, Tagami, and Shiota (1986). Depending on the species they showed that 88.0-96.5% of all variation in bottom fish weights is attributable to differences between lots. Therefore, by calculating the mean weights of fish in auction lots, it is possible to generate a size-frequency distribution by allocating fish to the size class of their lot mean (Ralston and Kawamoto 1985). A refinement is to estimate the weight variance within lots as a function of the species, lot weight, and number of fish (Ralston, Tagami, and Shiota 1986). Fish are then allocated to size categories in accordance with lot means and variances under the normal distribution. This procedure accounts for 97.2-99.3% of the total variation in bottom fish weight. In this study allocation was made solely according to lot means. It was found that the estimation of L_{∞} using the method of Wetherall et al. (in press) was sensitive to the largest size class represented in a length-frequency distribution. Mortality estimates were in turn very sensitive to values of L_{∞} . Because weight variance increases with a lot's weight and the number of fish comprising it, the process of allocation using both the mean and variance caused the presumptive assignment of fish to large weight categories, a result that could not be confirmed empirically. Allocation using only the mean weights is by comparison a more conservative approach to estimating L_{∞} . Still, the important point is that the weight distributions of the species studied here were estimated, undoubtedly with some error.

An even more important assumption is that the weight distributions derived from the catch (i.e., lot statistics) can be used as valid samples to infer something about the size structure of bottom fish populations in the wild. While evidence exists to show that hooks are capable of catching fish over a very broad range in size and that size structure is quite insensitive to alterations in gear (suggestive of constant selectivity) there are no data available to show that attack rates are independent of fish size. Intra-specific and behavioral interactions could alter the size composition of catch samples in ways we only partially understand (Allen 1963; Bannerot and Austin 1983). The interpretation of the descending limbs of length-frequency distributions relies critically on the assumption that catch samples are representative of the stock.

A third assumption is that snapper and grouper growth coefficients and natural mortality rates can be estimated with the comparative method. The graphs and equations presented in Manooch (1987) and Ralston (1987) permit the statistical prediction of "average" snapper and grouper vital rates from estimates of maximum size, but the extent to which the species studied here conform to such average expectations is unknown. However, at least one Hawaiian species (opakapaka) has been studied in some detail (Ralston and Miyamoto 1983; Ralston 1984). For this species the predictive estimates of vital rates are very similar to those determined by direct study.

An additional analytical simplification is that the Beverton and Holt (1956) length-based mortality estimator assumes that recruitment to the exploitable phase occurs at a constant uniform rate, and yet the spawning and recruitment of Hawaiian fishes is known to be seasonal (Walsh in press). Moreover, the length-frequency samples analyzed here represent an annual accumulation of fish in the catch. Ralston (in prep.) has shown, however, that the use of the Z/K length-based estimator is justified under such conditions. Pooling data from throughout the year results in an integrated average of stock size structure and obviates the bias due to seasonal recruitment.

Several important final assumptions are inherent in the formulation of the Beverton and Holt (1957) yield equation and underly the computation of yield per recruit. For one, this particular model assumes that recruitment to the exploitable phase is independent of stock size and fishing pressure. Over a fair range of stock conditions this assumption has been shown to be more or less realistic (Cushing 1973). Nevertheless, the subject of recruitment-overfishing is something that has not been seriously considered in this assessment. This topic deserves to be reviewed at some time in the future.

Moreover, application of the Beverton and Holt (1957) yield-per-recruit model presupposes that it is desirable to optimize the yield in biomass from a fish stock. Sometimes this may not be the case if, as a result of market conditions, a premium is placed on small fish. This may well be the case in the MHI fishery for ehu. It is possible to perform an assessment in which factors other than yield are optimized, although this has not been attempted here.

Lastly, the Beverton and Holt model is constructed under equilibrium conditions. Actually, there are several aspects of the present study in which this particular assumption is violated. The first relates to the computation of mortality rates from length-frequency distributions. As indicated previously, calculating vital rates based on length or age-frequency distributions from catch statistics provides a glimpse of historical conditions in the fishery (Ricker 1975). When these are altered through time, changes in size structure lag behind. Estimates of mortality derived here are, therefore, likely to be somewhat in error. Secondly, the actual composition of bottom fish populations under exploitation is in a state of flux. Strong evidence exists to show that the NWHI fleet has recently made significant changes in fishing grounds (Figs. 21 and 22). Thus, the fishery is not in equilibrium in time or space.

Given these principal assumptions, with their associated caveats, it is possible to draw several conclusions concerning the status of bottom fish stocks in the Hawaiian Islands.

The assessment in the MHI is generally consistent. Conditions seem to have been stable over the 1984-86 time period, as indicated by the uniformity in landing statistics (Table 3). There is evidence of growth-overfishing for three of the five species studied (opakapaka, ehu, and uku). An increase in the age at entry to the fishery would benefit all three

species. Minimum size limits would therefore seem warranted, especially for opakapaka. The harvest of 1 and 2 lb pound individuals is a biological waste in the short run and over the long term it could ultimately affect the ability of the stock to replenish itself. Although there are certain costs in implementing minimum size regulations, including those due to the mortality of released fish and the transition losses incurred in moving from one equilibrium state to another (Huntsman and Waters 1987), they only become more severe as growth-overfishing continues unabated.

Even though there is evidence of overfishing in the MHI for three of the most important species of bottom fish, the condition of hapuupuu and onaga stocks would seem to be much better. The assessment for onaga, in particular, is surprising. As indicated in Table 3, MHI catch totals for this species are substantial. Moreover, the length-frequency polygons of panel D in Figure 6 show that a broad size range of fish are entering the marketplace. Relatively speaking, large onaga are plentiful in the MHI. There is thus some justification for encouraging further exploitation of this resource.

With respect to the best available information concerning MSY, it is difficult to evaluate the MHI fishery for bottom fish. A figure of 285 t of sustainable yield has been given for this fishery. In 1986 landings at the wholesale market were about 130 t. The difficulty here is that there exists a harvest of fish that does not appear at the wholesale market, which is presently unaccounted for. Recreational fishing and sales of MHI fish through other market channels are believed equal in magnitude to the wholesale share of the fishery. Although more data are needed before a proper assessment relative to MSY can be made, the harvest of bottom fish in the MHI is probably close to MSY, if not in excess of it.

The situation in the NWHI is more complex. Opakapaka landings are in a state of decline as vessels fish farther up the archipelago in search of productive fishing grounds. The fishery is presently in a state of disequilibrium, a problem exacerbated by inadequate data on fishing locations in 1984 and 1985.

The yield-per-recruit analysis for NWHI opakapaka indicated that fishing mortality is actually declining. Bottom fish effort statistics indicate otherwise. The number of effective vessel trips has increased from 108 to 140 in 3 years, a 30% increase. The likely explanation for the apparent decrease in opakapaka fishing mortality rate is that the fleet has moved to the northwest and cropped the final vestiges of opakapaka populations in the NWHI. Henceforth the fishery for this species will likely be based on catch rates characteristic of a stock under moderate exploitation.

As fishing pressure in the farther reaches of the NWHI has increased landings of other, less desirable, species have risen. The catch of hapuupuu and butaguchi in the NWHI has doubled since 1984. The natural abundance of these species to the northwest of Raita Bank does not decline in parallel with opakapaka (Moffitt 1980). Given the extensive fishing activity in the vicinity of Northampton Seamounts and Lisianski Island in 1986, an increasing share of these species in the catch is thus to be

expected. Since new fishing grounds have been exploited this would explain the relatively low estimates of fishing mortality derived for the hapuupuu.

All evidence indicates that the onaga is starting to replace the opakapaka in the catch of NWHI bottom fishermen. Both are highly priced species that could support a fishery. Moreover, the yield-per-recruit analysis of NWHI onaga provided some justification for expanding fishing effort. An obstacle to the development of this fishery, however, is the shorter shelf life of onaga in comparison with opakapaka, a constraint that reduces the length of time vessels can stay on the fishing grounds.

In 1986 overall landings of bottom fish from the NWHI exceeded the best available estimate of MSY by 18%. In and of itself, this is not cause for alarm because the fishery is in a state of disequilibrium. The record harvest of 1986 is likely due in large part to the fishing-up of stocks as the fleet moved farther to the northwest. Nevertheless, there is every reason to be concerned about the biological condition of bottom fish stocks in the NWHI. With fishing activity so unstable the estimation and interpretation of vital rates from catch composition is severely compromised. One major improvement in our ability to monitor conditions within the fishery is the precise (i.e., bank specific) recording of fishing location. Without this type of data future assessments will be very much in jeopardy.

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